Quality Assurance and Quality Control Summary Report (1999 - 2009) for the Libby Asbestos Superfund Site

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Contents

Figures

Tables

Acronyms

<	less than
%	percent
ABS	activity-based sampling
AHERA	Asbestos Hazard Emergency Response Act
ASTM	American Society for Testing and Materials
AIHA	American Industrial Hygiene Association
ASB	Analytical Services Branch
C	coarse
CAR	corrective action request
CDM Smith	CDM Federal Programs Corporation
CFR	Code of Federal Regulations
CI	confidence interval
COC	chain of custody
CSF	Close Support Facility
CSS	Contaminant Screening Study
EDD	electronic data deliverable
EDS	energy dispersive spectroscopy
eLASTIC	electronic Libby Sample Tracking Information Center
EPA	Environmental Protection Agency
ESAT	Environmental Services Assistance Team
f/cc	fibers per cubic centimeter
f/mm^2	fibers per square millimeter
FG	fine ground
FSDS	field sample data sheet
FTL	field team leader
GIS	Geographic Information System
HAZWOPER	Hazardous Waste Operations and Emergency Response
HEPA	high-efficiency particulate air
ID	identification number
IDW	investigation-derived waste
IFF	information field form
ISO	International Organization for Standardization
ISSI	ISSI Consulting Group, Inc.
LA	Libby amphibole
LAN	local area network
LFO	Libby field office
LIMS	Laboratory Information Management System
MAS	Material Analytical Services, LLC
ND	non-detect
NIOSH	National Institute for Occupational Safety and Health
NIST	National Institute of Standards and Technology
NVLAP	National Voluntary Laboratory Accreditation Program
OA	other amphibole
OSHA	Occupational Safety and Health Administration
PAT	Proficiency Analytical Testing
PB	preparation blank

PCC	property completion checklist
PCM	phase contrast microscopy
PCME	PCM-equivalent
PDI	pre-design inspection
PE	performance evaluation
PLM	polarized light microscopy
PLM-Grav	polarized light microscopy gravimetric
PLM-VE	polarized light microscopy visual area estimation
PSDS	preparation sample data sheet
QA	quality assurance
QA/QC	quality assurance/quality control
QAM	quality assurance manager
QAPP	quality assurance project plan
QC	quality control
RESI	Reservoir Environmental Services, Inc.
RI	remedial investigation
RPM	Remedial Project Manager
SAED	selected area electron diffraction
SAP	sampling and analysis plan
s/cc	structures per cubic centimeter
SDG	sample delivery group
SOP	standard operating procedure
SPP	Soil Preparation Plan
SQL	structured query language
SRM	standard reference material
TEM	transmission electron microscopy
µm	micrometers
USGS	U.S. Geological Survey
Volpe	John A. Volpe National Systems Transportation Center
VPN	virtual private network

Section 1
Introduction

1.1 Project Background

Libby is a community in northwestern Montana that is located near a large open-pit vermiculite mine. Vermiculite from this mine contains varying levels of a form of asbestos referred to as Libby amphibole (LA). Historic mining, milling, and processing operations at the site, as well as bulk transfer of mining-related materials, tailings, and waste to locations throughout Libby Valley, are known to have resulted in releases of vermiculite and LA to the environment that have caused a range of adverse health effects in exposed people, including not only workers at the mine and processing facilities (Amandus and Wheeler 1987; McDonald *et al.* 1986, 2004; Whitehouse 2004; Sullivan 2007), but also in residents of Libby (Peipins *et al.* 2003, Noonan *et al.* 2006, Whitehouse *et al.* 2008).

Starting in December of 1999, the U.S. Environmental Protection Agency (EPA) began collecting samples of various types of environmental media (air, dust, soil, water, vermiculite insulation, bulk mine waste) to characterize the level of asbestos contamination in and about the community of Libby, and to help guide decisions about the need for the cleanup of sources of LA. The process of sample collection and analysis at the Libby site has generally been implemented in a series of discrete sampling programs, each with a specific purpose and design. **Table 1-1** provides a brief summary of the main data collection efforts that have been conducted at the site through December 2009.

1.2 Purpose of this Report

The purpose of this report is to describe the quality assurance (QA) plan that has been established at the Libby site[1] to govern the procedures for the collection and analysis of environmental samples for LA. This report also summarizes the results for a variety of different types of quality control (QC) samples that have been collected across the various sampling programs. This report provides information on the overall quality of the data collected at the Libby site through December 2009, and provides recommendations for refining and strengthening the QA/QC program in the future.

Note: This report focuses on QA procedures applied and QC samples collected at the Libby site through December 2009. Starting in January 2010, revised QA procedures, field and laboratory protocols, and data management practices were implemented at the Libby site. A summary of QA procedures and QC results since December 2009 will be included in a separate report.

[1] QA procedures and QC results for the operable unit (OU) in Troy, Montana (OU7) and the mine site (OU3) are not included in this report.

1.3 Report Organization

In addition to this introduction, this report contains the following sections:

Section 2 – Field Quality Assurance. This section describes the QA procedures developed and applied at the Libby site to ensure the proper collection, documentation, and handling of field samples.

Section 3 – Close Support Facility Quality Assurance. This section describes the QA procedures developed and applied at the Close Support Facility (CSF), a facility that is dedicated to preparation and processing of Libby soil samples for asbestos analysis.

Section 4 – Laboratory Quality Assurance. This section describes the QA procedures developed and applied at the Libby site to ensure the proper laboratory preparation and analysis of samples from the Libby site for asbestos.

Section 5 – Libby Database Quality Assurance. This section describes the QA program developed and applied at the Libby site to ensure that data entered into the site-specific database are accurate and complete.

Section 6 – Field Quality Control Evaluation. This section describes the results for QC samples collected to ensure data quality related to field sample collection and handling.

Section 7 – Close Support Facility Quality Control Evaluation. This section describes the results for QC samples collected to ensure data quality for soil samples prepared at the CSF.

Section 8 – TEM Laboratory Quality Control Evaluation. This section describes the laboratory QC analyses performed to ensure data quality for samples analyzed by transmission electron microscopy (TEM).

Section 9 – PCM Laboratory Quality Control Evaluation. This section describes the laboratory QC analyses performed to ensure data quality for samples analyzed by phase contrast microscopy (PCM).

Section 10 - PLM Laboratory Quality Control Evaluation. This section describes the laboratory QC analyses performed to ensure data quality for samples analyzed by polarized light microscopy (PLM).

Section 11 – Summary and Recommendations. This section summarizes the data quality conclusions from the Libby quality assurance/quality control (QA/QC) program and provides recommendations for changes to strengthen the QA/QC program in the future.

Section 12 – References. This section provides references to the detailed planning documents, methods, and procedures used at the site.

All tables and figures cited in the text are provided at the end of this report. Appendices are provided electronically on the enclosed compact disc or as a downloadable set of files.

Section 2
Field Quality Assurance

Field QA activities include all processes and procedures that have been designed to ensure that field samples are collected and documented properly, and that any issues/deficiencies associated with field data collection or sample processing are quickly identified and rectified. The following sections describe each of the components of the field QA program implemented at the Libby site.

2.1 Field Team Roles/Responsibilities

There are a variety of field personnel involved in the sampling programs for the Libby site, including:

- Site Manager – The site manager is responsible for ensuring that field efforts are conducted in accordance with the appropriate guidance documents relevant to the work being performed.
- Task Leader – The task leader is responsible for coordinating and implementing field program activities.
- Field Team Leader (FTL) – The FTL is responsible for ensuring that field team members collect resident and property information and samples in accordance with applicable standard operating procedures (SOPs) and field protocols.
- Field Team Member – The field team member is responsible for collecting resident and property information and samples in accordance with applicable SOPs and field procedures.
- Sample Coordinator – The sample coordinator is responsible for accepting custody of samples from the sampler(s) and properly packing and shipping the samples to the laboratory assigned to do the analyses.
- QA Manager (QAM) – The QA manager is responsible for ensuring that all field efforts are conducted in accordance with appropriate QA guidelines.

2.2 Field Team Training

Before performing field work in Libby, field personnel are required to read the *Comprehensive Site Health and Safety Program* (CDM Federal Programs Corporation [CDM Smith, formerly CDM] 2006) for the Libby site and the appropriate project-specific field guidance documents relevant to the work being performed. **Table 2-1** lists the Libby project field guidance documents that have governed field data and sample collection since sampling began in 1999 through December 2009.

Prior to participating in field work, all field personnel are required to attend program orientation. The purpose of program orientation is to review with each field team all relevant data and sample collection requirements specified in the field guidance documents. Program orientation is provided by a designated FTL. These FTLs are personnel who have participated in the development of the field guidance documents and are familiar with the applicable data collection strategies and required procedures and protocols. Attendance at program orientation is documented and submitted to the permanent project file repository located at the CDM Smith office in Denver, Colorado.

In addition, all field personnel must have current medical monitoring information on file and have completed the following field training:

- Occupational Safety and Health Administration (OSHA) 40-hour Hazardous Waste Operations and Emergency Response (HAZWOPER) and relevant 8-hour refreshers
- Respiratory protection, as required by 29 Code of Federal Regulations (CFR) 1910.134
- Asbestos awareness, as required by 29 CFR 1910.1001

In the field, independent assessments of work conducted by field personnel are performed by FTLs as part of ongoing field checks. During a field check, the FTL will revisit the property and independently verify the results of the field forms, including the property-specific details, residential survey information, and sampling collection information. If the FTL identifies information that has been recorded incorrectly by the field teams, the information is corrected and the teams are retrained to minimize future errors. Field checks for pre-design inspections (PDI) take place during field review of the removal design, which are performed at all PDI properties.

2.3 Field Documentation Review

Field documentation is the process of recording all relevant information about properties that are inspected and/or sampled. At the Libby site, field documentation is completed by field staff using property- and resident-specific field forms (e.g., primary building information field form [IFF], property completion checklist [PCC]), media-specific and sample-specific field sample data sheets (FSDSs), and logbook entries. The field forms and FSDSs that were created specifically for the Libby site provide a standardized method of documenting information generated in the field. This documentation is reviewed by the FTLs or sample coordinator on a regular basis to ensure that field information has been collected and recorded in accordance with the program-specific field guidance documents.

Completion checks are conducted by the FTLs on 100 percent (%) of field forms generated, and by the sample coordinator on 100% of FSDSs generated. The forms are reviewed for completeness (i.e., that every question has a response) and accuracy (i.e.,

consistency in responses for optimum retrieval of data). If no issues are identified, the reviewer will initial the form. If an issue is identified, the form is corrected and the field personnel responsible are retrained on proper documentation techniques. Reviewed and initialed forms are provided to the John A. Volpe National Transportation Systems Center (Volpe) in Cambridge, Massachusetts in both hard copy and electronic formats for entry and upload into the Libby project database (see Section 5).

Logbook entries are reviewed periodically by the QAM or an authorized QA staff member to ensure they meet the requirements stated in the SOP for *Field Logbook Content and Control* (CDM Smith SOP[2] 4-1). If any logbook entry is found to be recorded in a manner inconsistent with the SOP, the logbook entry is corrected and the field personnel responsible are retrained on proper documentation techniques. There is no pre-specified frequency for the review of logbook entries. Typically, reviews occur more frequently at the beginning of a sampling program to ensure that any potential issues are quickly identified and addressed.

2.4 Equipment Maintenance and Calibration

All field equipment is maintained in accordance with manufacturer specifications and the SOP for *Control of Measurement and Test Equipment* (CDM Smith SOP 5-1). When a piece of equipment is found to be operating incorrectly, the equipment will be labeled as "out of order" and placed in a separate area from the rest of the sampling equipment.

Prior to sample collection, each air or dust sampling pump is calibrated to the desired flow rate using a primary or secondary calibration standard (e.g., a rotameter that has been calibrated to the primary calibration standard) as described in EPA SOP #2015, *Asbestos Sampling* (EPA 1994).

2.5 Equipment Decontamination

Field equipment used in sample collection is decontaminated in accordance with the SOP for *Field Equipment Decontamination at Nonradioactive Sites* (CDM Smith SOP 4-5) and the Libby-specific SOP CDM-LIBBY-05, *Soil Sample Collection*. Any disposable equipment or other investigation-derived waste (IDW) is handled in general conformance with *Guide to Handling of Investigation-Derived Waste* (CDM Smith SOP 2-2).

The FTL performs periodic reviews of decontamination and IDW handling procedures. If field teams are observed not complying with the procedures found in the respective SOPs, they are re-instructed on correct procedures.

[2] All referenced CDM Smith SOPs are available in *CDM Smith Technical Standard Operating Procedures (Revision 19)* (CDM Smith 2007).

2.6 Field Quality Control Samples

Field QC samples are collected to help ensure that field samples are not contaminated from exogenous sources during sample collection, and to help evaluate the precision of field sample analytical results. Field QC samples are assigned unique field identifiers and are submitted to the analytical laboratory along with the associated field samples. Field duplicates/replicates/splits are submitted blind, meaning the analytical laboratories cannot distinguish field samples from field QC samples. However, because it is necessary to provide the sample-specific air volume (L) or dust sample area (cm^2) on the chain of custody (COC) for the purposes of calculating air concentrations and dust loadings, it is possible for the laboratories to distinguish field samples from blanks, which do not have an associated air volume or sample area.

A variety of different types of field QC samples are collected as part of investigations conducted at the Libby site. The program-specific field guidance documents or field modification forms specify the types and frequency of field QC samples that will be collected as part of each investigation. Since 1999, EPA has periodically adjusted field QC collection frequencies, as appropriate, based on a review of the available field QC results within each program and knowledge of changes in sampling/analytical practices. The purpose of these adjustments is to ensure that only those field QC samples necessary to assess the quality of sampling/analytical techniques are collected.

The following types of field QC samples are collected for air and dust:

- Lot blanks
- Field blanks
- Field duplicates/replicates

The following types of field QC samples are collected for soil:

- Field equipment blanks
- Rinsates
- Field duplicates
- Field splits

Section 6 provides a detailed description of each type of field QC sample and evaluates the results for all field QC samples collected at the Libby site.

Each field team is responsible for collecting the proper quantity and type of field QC samples. The Libby sample coordinator ensures that overall collection frequencies are met when more than one field team is collecting samples. Due to the large quantity of samples collected as part of several investigations (e.g., Contaminant Screening Study

[CSS]), a field QAM was appointed to monitor and document weekly field QC sample collection frequencies. Any deficiencies in the quantity or type of field QC samples collected were noted in the weekly QAM report, the FTL immediately notified, and field personnel promptly retrained as necessary. These weekly QAM reports are available in the project file repository located at the CDM Smith office in Denver, Colorado.

2.7 Sample Custody and Tracking

In accordance with Superfund policy and requirements, all samples at the Libby site are collected and transferred between locations using COC procedures in accordance with CDM Smith SOP 1-2, *Sample Custody*. During the initial investigations (December 1999-2000), COC forms were generated electronically using a project-specific Microsoft Access® database developed and maintained by ISSI Consulting Group, Inc. (ISSI). From 2001 to early 2002, after ISSI ceased to provide Libby project support, sample custody at the Libby site was tracked using hard copy COC forms by a contracted sample coordinator (Pacific Environmental Services, Inc.). Beginning in the spring of 2002 (before the start of the large-scale CSS sampling program), sample custody procedures evolved to utilize an electronic application that generated COCs. This application minimized transcription errors between field, laboratory, and data entry personnel, and allowed for real-time sample tracking in the field. These sample custody and tracking tools are discussed in more detail below.

2.7.1 Hard Copy Procedures

Sample Check-In

During the Phase 1 investigation (period between March 2001 and April 2002), hard copy COCs were used to inventory and transmit samples to the laboratory. Field personnel collected samples, recorded sample information on hard copy FSDSs, and prepared hard copy COCs. The field teams would then submit all paperwork and samples to the Libby sample coordinator for review. The sample coordinator would verify that the sample identification numbers (IDs) from the field samples matched the FSDSs and COCs, that information was filled out completely and correctly, and that all samples were packaged properly and custody sealed. If any discrepancies were found, the field teams immediately rectified the issue. Following this review process, the samples were formally relinquished to the sample coordinator.

COC Preparation and Sample Shipment

In preparation for shipment, each sample was placed in the sample shipping container and accounted for on the hard copy COC by placing a check mark next to each sample ID. Before sealing the shipping container, an independent field staff member would re-check the shipment to ensure that the contents and paperwork match and to verify that the correct analysis was requested. If any issues were identified, the sample coordinator was notified and the issue was immediately rectified.

Sample Tracking

During this time, sample tracking was performed using program-specific Microsoft® Excel spreadsheets. Limited sample information (e.g., sample ID, media, sampling date, etc.) was manually entered into these program-specific spreadsheets by field staff to allow for in-field sample tracking.

Data Transfer

Periodically (about once per week), the Libby sample coordinator would provide hard copies of all IFFs, FSDSs, and COCs to Volpe for data entry into the Libby project database (see Section 5).

2.7.2 Electronic Procedures

The use of hard copy COCs was successful in allowing samples to be quickly transmitted from the field to the analytical laboratories. However, the hard copy COCs and program-specific sample tracking spreadsheets did not allow field staff or project management to track the samples once they had been shipped and did not prevent transcription and other data entry errors from occurring. Correction of paperwork became a time-consuming task and a potential quality issue.

In preparation of the large-scale CSS effort (which began in May 2002), a sample tracking application was developed for the Libby project. The electronic Libby Asbestos Sample Tracking Information Center (eLASTIC) application feeds a Microsoft Access® database that serves as the data entry point for sample information in the field. This database allows the Libby sample coordinator to electronically select and place samples on an electronic COC form, which can then be printed and included with the sample shipment. Use of eLASTIC has been particularly important in preventing transcription errors between the field, laboratory, and project database, and has also increased overall efficiency of the field teams to handle large quantities of samples and field data. The eLASTIC database also allows for quick access to information needed for tracking and planning that was previously not available in the field.

Sample Check-In

Much like the hard copy process, once samples are collected and FSDSs are completed by the field teams, they are brought to the Libby sample coordinator for review. The sample coordinator verifies that sample IDs from the field samples match the FSDSs, that the FSDS was filled out completely and correctly, and that all samples were packaged properly and custody sealed. If any discrepancies were found, the field teams were able to immediately rectify the issue. Following this review process, the samples were formally relinquished to the sample coordinator.

eLASTIC Data Entry

Only information pertinent to the development of the electronic COC and sample tracking, such as property address, sample ID, date collected, and sample media, are manually entered into eLASTIC from the FSDSs and IFFs using electronic data entry

forms. The eLASTIC database has a variety of built-in QC functions that improve accuracy of data entry and help maintain data integrity. For example, data entry forms utilize drop-down menus whenever possible. Drop-down menus allow the data entry personnel to select from a set of standard inputs. The use of drop-down menus prevents duplication and transcription errors (e.g., when entering address information) and limits the number of available selections (e.g., media types). In addition, eLASTIC allows a unique sample ID to only be entered once, thus ensuring that duplicate records cannot be created.

In the field, sample coordination team members manually enter the subset of information relevant to COC preparation from the FSDSs into eLASTIC. Other field office personnel manually enter relevant information from the IFFs into eLASTIC. Once all required information has been entered, an independent field staff member reviews all data entry items against the FSDSs and IFFs. If any issues are identified, the reviewer immediately corrects any mistakes and provides feedback to the data entry personnel regarding the issue identified to prevent future errors. The eLASTIC application requires the reviewer to mark each sample, indicating that a QC check of all data entry fields has been completed. Samples cannot be included on a COC form unless a QC check has been completed.

COC Preparation and Sample Shipment

In order to generate an electronic COC, the Libby sample coordinator identifies (using drop-down menus in eLASTIC) the samples that will be included in the shipment, the laboratory, the analysis method requested, and the shipping carrier. The sample coordinator then enters the shipping tracking number and any specific instructions to the laboratory. Once entry of all relevant COC information is complete, the sample coordinator can print a test copy of the COC for review by an independent field staff member (e.g., the Libby sample coordinator assistant). **Figure 2-1** provides an example of an eLASTIC COC form. If any issues are identified, the sample coordinator is notified and the issue is immediately rectified. A final copy of the COC is printed and packaged with the samples. Shipments are verified by an independent field staff member (e.g., the Libby sample coordinator assistant) prior to shipment to ensure contents and paperwork match and to verify that the correct analysis was requested. If any issues are identified, the sample coordinator is notified and the issue is immediately rectified.

Samples are packaged and shipped in accordance with CDM Smith SOP 2-1, *Packaging and Shipping of Environmental Samples*. At the Libby site, vermiculite, shredded paper, or expanded polystyrene are not acceptable packing materials. The sample coordinator is responsible for performing a final check of the contents of a shipment before custody seals are placed on the shipping container.

Data Transfer

Each day, eLASTIC generates an electronic data deliverable (EDD) of all sample-specific information that has been entered that day. This sample EDD is provided daily to Volpe for upload into the Libby project database (see Section 5). An EDD of

all property-specific information entered by the field teams is usually provided weekly to Volpe for upload into the Libby project database. Periodically (about once per week), the Libby sample coordinator transmits hard copies of all field forms and FSDSs to Volpe. Volpe personnel are responsible for manually entering field form and FSDS information not captured in eLASTIC into the Libby project database (see Section 5).

2.8 Modification Forms

Prior to the start of the Phase 2 activity-based sampling (ABS) program (in early 2001), it was recognized that occasional modifications to sample collection procedures may be necessary due to the nature of the initial emergency response action. Any field modifications are documented on Libby Field Office (LFO) modification forms. **Figure 2-2** provides an example of the LFO modification form template. The LFO modification form provides a standardized format for tracking procedural changes in data or sample collection and allows project managers to assess potential impacts on the quality of the data being collected.

As seen in **Figure 2-2**, the LFO modification form contains the following information:

- The title of the field guidance document being modified
- A description of the process change
- The known or estimated impacts to data quality, including a list of potentially impacted sample IDs or addresses, as appropriate
- The name of the individual requesting the modification
- The dates the modification was implemented (may be temporary or permanent)
- The technical reviewer approval signature and date of review
- The QA reviewer approval signature and date of review

The LFO modification forms are controlled and maintained by the sample coordinator in Libby. **Table 2-2** provides a summary of all the LFO modification forms created through December 2009.

2.9 Field Audits

Field audits are conducted to evaluate field personnel in their day-to-day activities and ensure all processes and procedures are performed in accordance with the applicable field guidance documents (or approved LFO modification forms). Field audits are performed according to the schedule established by the EPA Remedial Project Manager (RPM) or EPA QAM, the Volpe Project Manager, and the CDM Smith QAM. Typically, field audits are scheduled at the beginning of a field investigation to identify any errors or inconsistencies early, thus preventing future

data collection from becoming compromised. All aspects of data and sample collection, as well as sample handling, custody, and shipping are evaluated. If any issues are identified, field personnel are notified and retrained as appropriate. Periodic follow-up field audits are also conducted to verify that any deficiencies noted during the earlier audits have been addressed and that no new issues have arisen.

Depending upon auditor availability, field audits may be internal or external. Internal field audits are performed by an EPA QA staff member or designate (such as the CDM Smith QAM) that is familiar with the Libby QA/QC program and the field activities being conducted. Internal field audits have been performed as part of all major field sampling efforts at the Libby site. Reports summarizing the internal field audit findings and recommendations for improvement, as well as follow-up audit reports, are available in the project repository at the CDM Smith office in Denver, Colorado.

External field audits are performed by an independent party selected by EPA and specializing in evaluating field programs. These external field audits include a technical evaluation and an evidentiary evaluation. The technical portion of the audit is based on the requirements described in the associated quality assurance project plans (QAPPs), sampling and analysis plans (SAPs), and SOPs. The evidentiary portion of the audit includes an evaluation of the completion of FSDSs, field logbooks, and COC forms as outlined in the EPA *Region 1 CSF Completeness Evidence Audit Program* (EPA 1991).

Four external audits have been conducted at the Libby site, one for each of the three indoor ABS scenarios of the Phase 2 Study and one during the CSS. The Phase 2 field audits were conducted by IT Corporation. The Phase 2 ABS Scenario 1 field audit was conducted from March 9-11, 2001, at three houses during sampling associated with routine indoor activities. The Phase 2 ABS Scenario 2 field audit was conducted on April 4, 2001, at two houses during sampling associated with household cleaning activities. The Phase 2 ABS Scenario 3 field audit was conducted from April 30 to May 2, 2001, at one house during simulated remodeling activities. The CSS field audit was conducted by IT Corporation on August 20-22, 2002, at several residential and commercial properties. Details of the field audit checklists, findings, and recommendations for improvement from each audit are provided in IT Corporation (2001a,b,c; 2002). These external field audit reports are available from the EPA Region 8 office in Denver, Colorado. While some deficiencies and inconsistencies were noted, the on-site evaluations concluded that the sampling teams were proficient, professional, and knowledgeable with regard to sample collection and documentation procedures. Most deficiencies were able to be immediately addressed; therefore, any impacts to sampling efforts were expected to be minimal.

Overall, these ongoing field audits have resulted in improved data collection efforts by ensuring that field personnel are performing work in a consistent and correct manner.

Section 3
Close Support Facility (CSF) Quality Assurance

CDM Smith operates the CSF in Denver, Colorado. The CSF was established in 2002 to prepare soil samples collected at the Libby site prior to asbestos analysis at the analytical laboratories. The *CSF Soil Preparation Plan (SPP)* (CDM Smith 2004a) serves as the guidance document for all activities at the CSF. The purpose of the SPP is to provide standard guidance on preparation methods to ensure that these procedures and resulting measurements are scientifically sound and of acceptable and documented quality.

The soil preparation procedures conducted at the CSF are described in detail in SOP ISSI-LIBBY-01 (SRC 2007), *Soil Sample Preparation*. **Figure 3-1** illustrates these soil preparation procedures in a flow diagram. In brief, the following activities occur:

- The raw field soil sample is dried and mixed.
- Using a riffle splitter, one portion of the raw sample is removed for archive, while the remainder is used for preparation of analytical samples.
- The sample for analysis is sieved through a coarse (¼-inch) screen. If any material is retained on top of this screen, it is designated as the "coarse" fraction.
- Material that passes through the coarse screen is referred to as the "fine" fraction. This fraction is passed through a plate grinder in order to reduce particles to a diameter of 250 micrometers (µm) or less. This "fine ground" fraction is divided into four aliquots using a riffle splitter, with one aliquot being sent for analysis, and the remainder held in archive.

The QA procedures that govern these soil preparation steps are described below.

3.1 Personnel Training

Personnel performing soil sample preparation activities at the CSF are required to have read and understood the *CSF SPP*, all associated SOPs, as well as the facility health and safety plan. In addition, all personnel must have current medical monitoring information on file and have completed 40-hour OSHA hazardous waste operations training and any 8-hour annual HAZWOPER refresher updates, as required.

3.2 Soil Sample Processing Procedures

3.2.1 Sample Receipt

The CSF receives soil samples from the Libby site *via* a commercial carrier. Upon receipt, samples are checked by the CSF sample coordinator to verify that the sample IDs match those listed on the shipment COC form. If any discrepancies are identified,

the CSF sample coordinator notes the discrepancy on the COC and notifies the Libby sample coordinator. The discrepancy is then corrected by the Libby sample coordinator and a revised copy of the COC is submitted to the CSF sample coordinator for the project file. Revised electronic COC information is also sent to the Volpe Center so the error may be reconciled in the Libby project database. If no issues are identified, the CSF sample coordinator notes on the COC that the shipment was complete.

To ensure that sample receipt procedures are being implemented correctly, once a week, during weeks when samples are received, all COC forms received during that day are reviewed and verified against the shipment contents by a second CSF staff member. If any discrepancies are noted, the issue is addressed using the procedures identified above and the individual is retrained on proper sample receipt techniques.

3.2.2 Sample Tracking

The CSF eLASTIC database is used to track various types of information related to soil preparation operations at the CSF. The CSF eLASTIC database is similar to the Microsoft Access® Field eLASTIC database utilized in the field to track samples and generate electronic COCs. However, these two eLASTIC databases are independent of each other. Sample-specific information from the field is provided to the CSF eLASTIC database for each incoming shipment *via* an EDD file from the Field eLASTIC database.

CSF personnel manually enter preparation-specific information for each sample into CSF eLASTIC using electronic data entry forms. The CSF eLASTIC database has a variety of built-in QC functions that improve accuracy of data entry and help maintain data integrity. For example, data entry forms utilize drop-down menus whenever possible. Drop-down menus allow the data entry personnel to select from a set of standard inputs. The use of drop-down menus prevents transcription errors and limits selections to a standard list of acceptable entries.

The types of preparation-specific information recorded includes the incoming field COC numbers and associated inventory batches, sample fraction weights, preparation QC sample information, outgoing CSF COC numbers, the analytical laboratories to where processed samples are sent, the analysis method requested, and sample inventory information.

Once all required information is entered for a sample, an independent CSF staff member reviews all data entry items. If any issues are identified, the reviewer immediately corrects any mistakes and provides feedback to the data entry personnel regarding the issue identified to prevent future errors. The data entry check is documented in the CSF logbook. The CSF eLASTIC application also requires the reviewer to mark each sample, indicating that a QC check of all data entry fields has been completed. Samples cannot be included on an outgoing CSF COC form unless a QC check has been completed.

CSF eLASTIC generates an EDD of preparation-specific information that has been entered by the CSF personnel. This preparation EDD is provided to Volpe for upload into the Libby project database (see Section 5). The frequency of the preparation EDD submittal to the Volpe Center depends upon the number of samples prepared each day. Only records that have been checked by a CSF reviewer are submitted to Volpe for upload into the Libby project database.

3.2.3 Sample Storage

All samples at the CSF are stored in accordance with the procedures described in SOP ISSI-LIBBY-01. Whether processed or unprocessed, soil samples are stored in double sealed zip-top bags and filed in cardboard boxes by inventory batch number. Soil samples do not require refrigeration. Each storage box is labeled with the inventory batch number and the sample IDs of the each sample being stored. These storage boxes are arranged in numerical order by inventory batch number for easy retrieval. Boxes are stored in a locked room at a separate location on the CSF property (supplemental storage is also available within the CSF).

3.2.4 Sample Shipping

For every sample shipment from the CSF, the CSF sample coordinator verifies the visual appearance of each sample against the sample ID suffix (which identifies the soil fraction as coarse [C] or fine ground [FG]) to ensure that samples are labeled correctly.

Electronic COCs are generated in CSF eLASTIC. A hard copy of the COC is printed and included with the sample shipment. Sample shipments are verified by an independent CSF staff member prior to shipment to ensure contents and paperwork match and to verify that the correct analysis was requested. If any issues are identified, the CSF sample coordinator is notified and the issue is immediately rectified. The CSF personnel responsible for the error are retrained on proper sample shipping techniques. If no issues are identified, the reviewer initials and dates the COC, records the COC number(s), and notes that a QC check was completed in the CSF logbook.

3.3 Equipment Calibration

In accordance with the procedures described in SOP ISSI-LIBBY-01, prior to use each day, the scales used determine soil sample weights are calibrated using S-1 class weights, and ventilation hoods and drying ovens are calibrated in accordance with manufacturer guidelines. In addition, the plate grinder is calibrated daily (or after any adjustments are made to the plates), to verify proper particle size (approximately 250 µm) and demonstrate that samples are not being over-processed, by grinding a sample of clean soil as provided by the U.S. Geological Survey (USGS).

3.4 Equipment Decontamination

Equipment decontamination procedures are detailed in SOP ISSI-LIBBY-01. In brief, ventilation hoods and drying ovens are vacuumed using a vacuum equipped with a high-efficiency particulate air (HEPA) filter and all surfaces are wet-wiped between each batch of samples. All sample containers and pans, sieves, the splitter, and the plate grinder are decontaminated between each soil sample using a HEPA vacuum and compressed air. If the plate grinder cannot be easily disassembled, an aliquot of quartz sand is processed through the grinder to clean out any residual soil.

3.5 Soil Preparation Quality Control Samples

Soil preparation QC samples are collected to ensure proper sample handling and decontamination of soil preparation equipment. Two types of preparation QC samples are included for analysis – preparation blanks and preparation duplicates. Preparation QC samples are assigned unique field identifiers and are submitted blind to the analytical laboratory along with the field samples. Thus, the analytical laboratories cannot distinguish field samples from preparation QC samples. Information about each type of preparation QC sample is recorded in the Preparation Sample Data Sheet (PSDS).

Section 7 provides a detailed description of each type of soil preparation QC sample and evaluates the results for all soil preparation QC samples analyzed at the Libby site.

3.6 Laboratory Documentation Review

The CSF documentation consists of batch sample preparation forms, PSDSs, CSF logbook entries, and calibration and maintenance logs. These forms and logs were created specifically for the Libby site, and were designed to allow for a standardized method of documenting information generated in the CSF. This documentation is reviewed by the CSF sample coordinator and CSF personnel on a regular basis to ensure that preparation information is recorded in accordance with the SPP.

- **Batch Sample Preparation Forms –** On each day sample processing occurs, the CSF sample coordinator checks the batch sample preparation forms to ensure all entries are complete and correct.

- **PSDSs –** Once the PSDS has been completed, a CSF staff member (other than the individual who completed the original PSDS) will check to ensure the data are accurate and complete.

- **Logbooks –** On a weekly basis, a CSF staff member (other than the individual who completed the original logbook entries) will check the logbook entries.

- **CSF Calibration and Maintenance Logs –** All equipment calibration and maintenance information is recorded in the equipment calibration and maintenance logs. On each day sampling processing occurs, the CSF sample coordinator performs a 100% check of calibration and maintenance logs to ensure the documentation and calibration procedures were completed and that no equipment issues were noted during calibration.

3.7 Quality Assurance Manager Report

The CSF QAM report is a checklist developed specifically for the CSF to ensure that all QA/QC procedures outlined in the *CSF SPP* are performed, including preparing and submitting CSF QC samples (e.g., preparation blanks) at designated frequencies. The QAM uses information provided by the CSF sample coordinator to assess whether all QA/QC requirements have been met. The completed checklist is sent to the CDM Smith Project Manager, the EPA Regional Chemist, Volpe, and the CDM Smith project files.

If any deficiencies are noted during a QAM checklist review, the CDM Smith Project Manager and/or the CSF sample coordinator will be notified by the QAM and the appropriate corrective action will then be determined by the CDM Smith Project Manager, QA staff member, and/or the QAM. If the corrective action can be immediately implemented, then the deficiency will be immediately rectified. If the corrective action cannot be (or is not) immediately implemented, then an improvement plan will be developed to address the issue identified. If the actions included in the improvement plan are not completed by the due date indicated in the plan, the CDM Smith Project Manager, QAM, and CSF sample coordinator will resolve the issue. If the deficiency cannot be resolved within a week after the improvement plan due date, a corrective action request (CAR) form will be issued.

3.8 Modification Forms

All activities performed at the CSF are to be performed in accordance with SOPs identified in the *CSF SPP*. Changes from these SOPs are documented using the CSF record of deviation/modification form. **Figure 3-2** provides an example of the CSF modification form template. The CSF modification form provides a standardized format for tracking procedural changes in sample preparation and allows project managers to assess potential impacts on the quality of the sample results. Each modification request must be approved in writing by the EPA Project Chemist (or delegate), the Volpe Center Project Manager (or delegate), and the CDM Smith Project Manager (or delegate) prior to implementation. The CSF modification forms are controlled and maintained by the EPA laboratory contractor (CDM Smith). **Table 3-1** summarizes the CSF modification forms that have been approved and implemented through December 2009.

3.9 CSF Audits

Audits of the CSF are conducted periodically to evaluate CSF personnel in their day-to-day activities and ensure that all processes and procedures are performed in

accordance with the *CSF SPP* (or approved CSF modification forms). All aspects of sample preparation, as well as sample handling, custody, and shipping are evaluated. If any issues are identified, CSF personnel are notified and retrained as appropriate.

In accordance with the *CSF SPP*, CDM Smith conducted a laboratory audit of the CSF on March 18, 2004 (CDM Smith 2004b). Specific activities that were audited included:

- Laboratory organization and personnel
- Sample receipt and storage
- General laboratory facilities
- Sample preparation procedures
- Sample shipping/weighting procedures
- General housekeeping
- CSF measurements
- QA/QC procedures

An audit report (CDM Smith 2004c) was issued on April 29, 2004, which included the audit checklists, audit results, and CARs. Formal responses to the CARs were submitted on June 28, 2004, and an audit completion notice was issued on June 29, 2004 (CDM Smith 2004d). EPA and Shaw Environmental, Inc. performed an audit on October 2, 2008. The audit report was issued on March 20, 2009 (Shaw Environmental, Inc. 2009). Formal responses to the audit findings are in the process of being completed.

3.10 CSF Contamination Monitoring

In May 2003, CDM Smith collected a series of ambient stationary air samples, personal air samples, and microvacuum dust samples at the CSF. The purpose of these samples was to evaluate worker safety and help assess the potential for cross-contamination of samples submitted to the facility. Ambient stationary air samples were collected during one full 8-hour day of processing. Personal air samples were collected for three consecutive days of sample processing. In accordance with the *CSF SPP*, on each day, one 8-hour time-weighted average sample and one 30-minute excursion sample were collected for sample coordination and sample preparation personnel, respectively. **Table 3-2** presents the acceptance criteria and corrective actions that were established for each type of CSF monitoring sample.

CDM Smith (2003a) summarizes the detailed results of the May 2003 CSF monitoring. In brief, all air samples analyzed by PCM met the acceptance criteria. However, several air and dust samples analyzed by TEM were above the specified acceptance criteria. Therefore, corrective actions were taken, including wet-wiping and HEPA

vacuuming the facility. In addition, two facility changes were made: 1) a second ventilation hood was added in the main laboratory; and 2) sample storage was moved to a detached building behind the CSF (CDM Smith 2003b). Several procedural changes were also made, including re-bagging the soil sample following drying and performing drying under a negative flow ventilation hood (CDM Smith 2003b).

After these corrective actions were completed, a second monitoring assessment of the CSF was performed in June 2003. A series of ambient stationary air samples, personal air samples, and microvacuum dust samples were collected and analyzed by PCM and/or TEM. CDM Smith (2003b) summarizes the detailed results of the June 2003 CSF monitoring. In brief, all air and dust samples met the acceptance criteria. These results indicate that the facility and procedural changes implemented at the CSF following the May 2003 assessment prevented any further release of LA. Since June 2003, more than 400 air and dust samples have been collected at the CSF during subsequent monthly monitoring efforts when the CSF has been processing soil samples. A review of these air and dust samples show that CSF monitoring samples have continued to meet the acceptance criteria for TEM, but have occasionally exceeded the acceptance criteria for PCM (see **Table 3-3**). In these cases, a formal corrective action report was not prepared; however, corrective actions, including increased cleaning procedures, were performed upon receipt of the analytical data.

Section 4
Laboratory Quality Assurance

Laboratory QA activities include all processes and procedures that have been designed to ensure that data generated by an analytical laboratory are of high quality and that any problems in sample preparation or analysis that may occur are quickly identified and rectified. The following sections describe each of the components of the analytical laboratory QA program implemented at the Libby site.

4.1 Analytical Methods Overview

4.1.1 PCM

Historically, the most common technique for measuring asbestos in air has been PCM. The standard PCM method for the analysis of air is National Institute for Occupational Safety and Health (NIOSH) Method 7400, Issue 2. This method provides a full description of how samples should be collected, prepared, and examined. Under NIOSH 7400, a fiber is defined as any particle more than 5 μm in length with an aspect ratio ≥ 3:1. The limit of resolution of PCM is about 0.25 μm, so particles thinner than this are not observable. A key attribute of PCM is that particle discrimination is based only on morphology. Because of this, it is not possible to classify asbestos structures by mineral type, or even to distinguish between asbestos and non-asbestos. At the Libby site, PCM has primarily been used to analyze personal air samples for workers collected as part of OSHA health and safety requirements.

4.1.2 TEM

TEM is a common method for analysis of air and dust samples for asbestos. TEM utilizes a high-energy electron beam to irradiate the sample which allows visualization of structures much smaller than can been seen by PCM. Most TEM instruments are fitted with one or both of two supplemental instruments that allow a more detailed characterization of a particle than is possible under PCM:

EDS (energy dispersive spectroscopy) is a method that takes advantage of the fact that an atom that is excited by absorbing a high-energy electron will tend to re-emit the absorbed energy at a wavelength that is characteristic of the absorbing atom. Thus, when a particle is examined under a TEM instrument equipped with EDS, it is possible to obtain data on the atomic composition of each particle being examined. This makes it easy to distinguish organic fibers from mineral fibers, and also allows for distinguishing between different types of mineral fibers.

SAED (selected area electron diffraction) is a method based on the fact that crystalline structures diffract electrons to form a diffraction pattern that is characteristic of the underlying crystal structure. Thus, when a particle is examined under a TEM instrument equipped with SAED, it is possible to obtain a diffraction pattern that is helpful in distinguishing organic from mineral fibers, and in classifying the nature of the mineral fiber.

Because of the higher magnification and the ability to differentiate particles on the basis of both elemental content (EDS) and crystal structure (SAED), TEM is a much more powerful technique than PCM. Air and dust samples collected at the Libby site are analyzed by TEM.

There are many different standard methods that have been developed for TEM. These methods differ mainly in the counting rules that specify the nature of the particles that are to be recorded during an analysis. The counting rules for the two main methods utilized at the Libby site are briefly discussed below.

ISO 10312:1995(E)

Under International Organization for Standardization (ISO) 10312 counting rules, a fiber is defined as any structure ≥ 0.5 µm that has substantially parallel sides and an aspect ratio ≥ 5:1. At the Libby site, this aspect ratio rule has varied over time (see LB-000016A), with more recent samples analyzed using an aspect ratio rule of ≥ 3:1, which allows for the estimation of PCM-equivalent (PCME) structures. ISO 10312 employs a fairly complex set of rules for counting fibers that occur in higher order structures (e.g., matrices, clusters), tending to enumerate individual fibers when they can be clearly distinguished, and counting the higher order particles as a unit when the individual fibers cannot be clearly resolved.

AHERA

A second counting method that has been used at the Libby site is described in the regulations established for evaluating asbestos risks in schools under the Asbestos Hazard Emergency Response Act (AHERA). Counting rules under AHERA are similar to ISO 10312, except that higher order structures are usually not broken down into their elements but are recorded as single structures. AHERA counting rules are typically used in the analysis of air samples collected to meet health and safety requirements. Dust samples analyzed in accordance with American Society for Testing and Materials (ASTM) D5755 also utilize AHERA counting rules.

4.1.3 PLM

The asbestos analysis technique most widely used for soil is PLM. This method is based on the fact that light passing through a translucent mineral will interact with the internal crystal structure of the mineral grains, and the transmitted light (that which passes through the particle) tends to be polarized, having a higher intensity in some orientations than in others. Because this effect depends on the composition and/or structure of the particle, each mineral has a unique affect on light passing through it. Thus, based on the optical properties (e.g., refractive index, birefringence) of the particle, it is possible to distinguish asbestos from non-asbestos, and to classify different types of asbestos.

Soil samples collected at the Libby site are analyzed by PLM using visual area estimation. In this approach, the microscopist examines a slide and estimates the fraction of the total area of all particles that are asbestos particles. PLM visual area

estimation differs from other asbestos analysis methods (e.g., TEM or PCM) in that results are reported semi-quantitatively.

Historically, all soil samples at the Libby site were analyzed using NIOSH Method 9002, Issue 2, which reports results as non-detect (ND), detected at a level less than 1% (<1%), or detected at a level of 1% or higher. Beginning in early 2003, most investigative[3] soil samples at the Libby site have been analyzed using Libby-specific SOPs for stereomicroscopic examination (SOP SRC-LIBBY-01 [SRC 2004]), referred to as "PLM-Grav") and PLM visual area estimation (SOP SRC-LIBBY-03 [ESAT 2008]), referred to as "PLM-VE"). The PLM-VE method is similar to NIOSH 9002, except that soil samples are sieved and ground at the CSF prior to analysis (see Section 3) and the visual area estimation utilizes site-specific LA reference materials to allow for the assignment of samples into four semi-quantitative bins, as follows:

- *Bin A (ND):* non-detect
- *Bin B1 (Trace):* detected at levels lower than the 0.2% LA reference material
- *Bin B2 (<1%):* detected at levels lower than the 1% LA reference material but higher than or equal to the 0.2% LA reference material
- *Bin C:* detected at levels greater than or equal to 1%; a quantitative estimate of the detected level is reported (e.g., 3%)

Of the more than 23,000 soil field samples that have been prepared for analysis by PLM-VE, about 12,900 of these samples have a coarse fraction that has been analyzed by PLM-Grav. Nearly all (99.3%) of these coarse fraction samples were reported as non-detect for LA. When LA was detected in the coarse fraction, the PLM-Grav result is reported as "trace" for all samples. With few exceptions, the results of the PLM-Grav analysis are unlikely to increase the estimates of LA in soil derived based on PLM-VE analysis of the fine, ground fraction. Therefore, this report does not include an evaluation of PLM-Grav results.

4.2 Participating Analytical Laboratories

At the beginning of the Libby project, three analytical laboratories were under contract to EPA to perform analytical work at the site, including EMS Laboratories, Inc. in Pasadena, California, EMSL Analytical, Inc. in Westmont, New Jersey, and Reservoir Environmental Services, Inc. (RESI) in Denver, Colorado. Following the results from an EPA on-site audit that identified performance concerns and a lack of interest to provide continued support for future Libby work, EMS Laboratories, Inc. ceased performing analytical support to the Libby site in February 2001. Because of the backlog of analytical work to be completed and the required turnaround times needed as part of the ongoing activities at the site, Hygeia Laboratories, Inc. in Sierra

[3] Soil samples collected in support of cleanup design and confirmation sampling (i.e., "non-investigative" samples) are analyzed by NIOSH 9002 to allow for rapid turn-around of results reporting.

Madre, California, and Batta Laboratories, Inc. in Newark, Delaware, were added to the laboratory team in the fall of 2001. Material Analytical Services, LLC (MAS) in Suwanee, Georgia, was added in the fall of 2002. All commercial laboratories were contracted to and managed by CDM Smith. In the summer of 2008, EPA's Environmental Services Assistance Team (ESAT) at the Region 8 laboratory in Golden, Colorado, began performing PLM analyses in support of the Libby program.

In addition to these off-site analytical laboratories, the Libby site also has an on-site laboratory that is owned and staffed by EMSL Analytical, Inc. This on-site laboratory is referred to as the "Mobile Lab" based on its original founding – inside a customized trailer. The Mobile Lab operation was established in June 2000 and was upgraded to a fixed-based facility in the fall of 2005.

4.3 Laboratory Certifications

All analytical laboratories participating in the analysis of samples for the Libby project are subject to national, local, and project-specific certifications and requirements. Each laboratory is accredited by the National Institute of Standards and Technology (NIST)/National Voluntary Laboratory Accreditation Program (NVLAP) for the analysis of airborne asbestos by TEM and/or analysis of bulk asbestos by PLM. This includes the analysis of NIST/NVLAP standard reference materials (SRMs), including SRM 1866, 1867, 1876b, 8411, and 2063a (see **Table 4-1**), or other verified quantitative standards, and successful participation in two proficiency rounds per year each of bulk asbestos by PLM and airborne asbestos by TEM supplied by NIST/NVLAP.

In addition, PCM laboratories are required to successfully participate in the proficiency analytical testing (PAT) program of the American Industrial Hygiene Association (AIHA). These are PCM proficiency testing samples submitted to the laboratories quarterly, directly from AIHA.

Copies of recent proficiency examinations from both NVLAP and the AIHA or an equivalent program are maintained for each participating analytical laboratory in the Libby project files. Many of the laboratories also maintain certifications from other state and local agencies.

Each laboratory working on the Libby project is also required to pass an on-site EPA laboratory audit. The details of this EPA audit are discussed in Section 4.8. The EPA laboratory contractor (CDM Smith) also reserves the right to conduct any additional investigations deemed necessary to determine the ability of each laboratory to perform the work. Each contracted laboratory is obligated to provide CDM Smith with any information requested for this purpose.

4.4 Laboratory Quality Control Samples

A variety of laboratory-based QC analyses are performed to help establish the quality of data obtained by TEM, PCM, and PLM, as discussed below.

4.4.1 TEM

The QC requirements for TEM analyses at the Libby site are patterned after the requirements set forth by NVLAP. The types of laboratory QC samples for TEM include the following:

- Laboratory blanks
- Recount same (same grid openings, same analyst)
- Recount different (same grid openings, different analyst, same laboratory)
- Interlab (same grid openings, different analyst, different laboratory)
- Repreparation (new grid and grid openings)

Laboratory Modification LB-000029B summarizes the Libby program-wide TEM QC frequency rates, selection protocols, and acceptance criteria for all participating TEM laboratories. Section 8 provides a summary of the results for these various types of TEM-based laboratory QC analyses.

4.4.2 PCM

Laboratory-based QC samples for PCM are based on the requirements specified by AIHA. This includes daily checks of microscope resolution, daily analysis of one or more reference slides (slides analyzed repeatedly over time to determine the precision of each analyst), and re-analysis of at least 10% (a minimum of 1 per day) of all field samples. Section 9 provides a summary of the results for these various types of PCM-based laboratory QC analyses.

4.4.3 PLM

Laboratory-based QC for PLM is based on the requirements specified by NIST/NVLAP and includes inter- and intra-analyst re-analyses (laboratory duplicates), interlabs, and analysis of performance evaluation (PE) standards. As specified in SOP SRC-LIBBY-03, laboratory duplicates for PLM-VE are to be performed at an overall frequency of 10% (1 per 10 analyses). Laboratory Modification LB-000073 summarizes the Libby program-wide PLM-VE interlab analysis frequency rates and acceptance criteria. Section 10 provides a summary of the results for these various types of PLM-based laboratory QC analyses.

4.5 Training

4.5.1 Initial Mentoring

To ensure that new laboratories and their analysts are properly trained to perform reliable analyses at the Libby site, a program was established in which laboratories who are experienced with the analysis of LA provide training and mentoring to the new laboratories prior to their involvement with the analysis of Libby field samples. All new laboratories, including new analysts at each laboratory, are required to

participate in the mentorship/training program. The training program includes a rigorous 2-3 day period of on-site training provided by senior personnel from those laboratories who are highly experienced with the Libby project. The tutorial process includes a review of morphological, optical, chemical, and electron diffraction characteristics of LA, as well as training on the project-specific analytical methodology, documentation, and administrative procedures required for the Libby site.

4.5.2 Site-Specific Reference Materials

TEM

Because LA is not a common form of asbestos, USGS prepared three site-specific reference materials using LA collected at the Libby mine site (EPA 2008a). Upon entry into the Libby program, each laboratory was provided samples of these LA reference materials. Each laboratory analyzed multiple LA structures present in these samples by TEM in order to become familiar with the physical and chemical appearance of LA and to establish a reference library of LA EDS spectra. These laboratory-specific and instrument-specific LA reference spectra (EPA 2008a) serve to guide the classification of asbestos structures observed in Libby field samples during TEM analysis.

PLM

USGS has also prepared site-specific reference materials of LA in soil for use during PLM-VE analysis (EPA 2008b). These reference materials were prepared by adding aliquots of LA spiking material to uncontaminated Libby soils to obtain nominal LA concentrations of 0.05%, 0.2%, 0.5%, 1.0%, and 2.0% (by weight). Each laboratory was provided with samples of these reference materials for use in training PLM analysts in the visual area estimation of LA levels in soil. In addition, aliquots of these reference materials (as well as other spiked soils) are also utilized as PE standards to evaluate PLM laboratory accuracy.

4.5.3 Regular Technical Discussions

To ensure that all laboratories are aware of any technical or procedural issues and requirements, a weekly teleconference was held between EPA, their contractors, and each of the participating laboratories. Other experts (e.g., USGS) were invited to participate when needed. These calls covered all aspects of the analytical process, including sample flow, information processing, technical issues, analytical method procedures and development, documentation issues, project-specific laboratory modifications, and pertinent asbestos publications. Regular laboratory teleconferences ended in January 2009.

4.5.4 Professional Meetings

Another important aspect of laboratory team training has been the participation in technical conferences. The first of these technical conferences was hosted by USGS in Denver, Colorado, in February 2001, and was followed by another held in December 2002. The Libby laboratory team has also convened on multiple occasions at the ASTM Johnston Conference in Vermont, including July 2002, July 2005, and July 2008.

In addition, members of the Libby laboratory team attended an EPA workshop to develop a method to determine whether LA is present in a sample of vermiculite attic insulation held in February 2004 in Alexandria, Virginia. These conferences enable the Libby laboratory and technical team members to have an ongoing exchange of information regarding all analytical and technical aspects of the project, including the benefits of learning about developments by others.

4.6 Data Recording

Standardized data entry spreadsheets (electronic data deliverables, or EDDs) have been developed specifically for the Libby project to ensure consistency between laboratories in the presentation and submittal of analytical data. In general, a unique Libby-specific EDD was developed for each type of analytical method. Since the beginning of the Libby project, each EDD has undergone continued development and refinement to better accommodate current and anticipated future data needs and requirements. EDD refinement continues based on laboratory and data user input.

The EDDs for reporting of PCM and PLM NIOSH 9002 results are derived from standardized outputs from the Laboratory Information Management System (LIMS). LIMS is a software system used by laboratories to integrate laboratory instrument software, sample management, and results reporting. The LIMS-generated EDDs are uploaded via Microsoft® Excel export file directly into the Libby project database.

The EDDs for TEM and PLM-VE are Microsoft Excel® spreadsheets developed specifically for use at the Libby site by SRC, Inc (formerly Syracuse Research Corporation). Each EDD contains a variety of built-in QC functions that improve the accuracy of data entry and help maintain data integrity. For example, data entry forms utilize drop-down menus whenever possible to standardize data inputs and prevent transcription errors. In addition, many data input cells are coded to highlight omissions, apparent inconsistencies, or unexpected values so that data entry personnel can check and correct any errors before submittal of the EDD. These spreadsheets also perform automatic computations of analytical sensitivity, dilution factors, and concentration, thus reducing the likelihood of analyst calculation errors. The EDD is uploaded directly into the Libby project database, avoiding any additional data entry requirements. **Appendix A** provides copies of the site-specific EDDs for TEM and PLM-VE developed for use at the Libby site.

4.7 Laboratory Modification Forms

When changes or revisions are needed to improve or document specifics about analytical methods or procedures used by the Libby laboratory team, these changes are documented using laboratory modification forms. The laboratory modification form provides a standardized format for tracking procedural changes in sample analysis and allows project managers to assess potential impacts on the quality of the data being collected. **Figure 4-1** provides an example of the laboratory modification form. As seen, the laboratory modification form contains the following information:

- The title of the analytical method being modified
- A description of the process change
- The known or estimated impacts to data quality, including a list of potentially impacted sample IDs as appropriate
- The name of the individual requesting the modification
- The dates the modification was implemented (may be temporary or permanent)
- The technical reviewer approval signature and date of review
- The QA reviewer approval signature and date of review

The laboratory modification forms are controlled and maintained by the EPA laboratory coordinator (CDM Smith). **Table 4-2** summarizes the laboratory modifications that have been implemented through December 2009.

4.8 Laboratory Audits

4.8.1 External Audits

Each of the analytical laboratories for the Libby site is required to participate in an on-site laboratory audit carried out by the EPA Superfund Analytical Services Branch (ASB). These audits are performed by EPA personnel (and their contractors) external to, and independent of, the Libby team members. These audits ensure that each analytical laboratory meets the basic capability and quality standards associated with analytical methods for asbestos used at the Libby site. They also provide information on the availability of sufficient laboratory capacity to meet potential testing needs associated with the Libby site.

Audits consist of several days of technical and evidentiary review of each laboratory. The technical portion of the audit involves an evaluation of laboratory practices and procedures associated with the preparation and analysis of bulk and air samples for the identification of asbestos-containing material. The evidentiary portion of the audit involves an evaluation of data packages, record keeping, SOPs, and the laboratory QA manual. The evidentiary audit follows the procedures outlined in the EPA *Region 1 CSF Completeness Evidence Audit Program* (EPA 1991). A checklist of method-specific requirements for the commonly used methods for asbestos analysis, including PLM, TEM, and PCM, is prepared by the ASB contractor prior to the audit, and used during the on-site laboratory evaluation.

Evaluation of the capability for a laboratory to analyze a sample by a specific method is made by observing analysts performing actual sample analyses and interviewing each analyst responsible for the analyses. Observations and responses to questions concerning items on each method-specific checklist are noted. The determination as to whether the laboratory has the capability to analyze a sample by a specific method

depends on how well the analysts follow the protocols detailed in the formal method, how well the analysts follow the laboratory-specific method SOPs, and how the analysts respond to method-specific questions.

Evaluation of the laboratory to be sufficient in the evidentiary aspect of the audit is made by reviewing laboratory documentation and interviewing laboratory personnel responsible for maintaining laboratory documentation. This includes personnel responsible for sample check-in, data review, QA procedures, document control, and record archiving. Certain analysts responsible for method quality control, instrument calibration, and document control are also interviewed in this aspect of the audit. Determination as to the capability to be sufficient in this aspect is made based on staff responses to questions and a review of archived data packages and quality control documents.

An on-site audit report is available for each analytical laboratory participating in the Libby program and is kept in the Libby Lab eRoom in laboratory-specific folders that have restricted access to the eRoom coordinator(s), CDM Smith laboratory manager, Volpe, EPA, and associated laboratory eRoom members. These are handled as business confidential items. The On-site Audit Report includes both a summary of the audit results and completed checklist(s), as applicable. Responses from each laboratory to any deficiencies noted in the On-site Audit Report are also maintained with the respective reports.

Two external audits of the Libby analytical laboratories have been performed. The first series of audits was conducted in January of 2001, and evaluated EMS Laboratories., EMSL Analytical, and RESI. Because of performance concerns noted during this audit, EMS Laboratories was voluntarily released from the Libby laboratory program. The second series of audits was conducted in the summer/fall of 2008, and evaluated EMSL Analytical (6 locations), RESI, Hygeia Laboratories, Batta Laboratories, MAS, and ESAT. No critical deficiencies were noted during the 2008 laboratory audits, however, these documents have not been finalized by EPA. As such, formal responses to the audit findings are still in the process of being completed.

4.8.2 Internal Audits

Each laboratory conducts internal audits of their specific operations on an annual basis using appropriate checklists. The current overarching quality framework used by testing laboratories follows both NVLAP and AIHA checklists that are ISO 17025:2005 compliant. During on-site audits that are performed by certifying inspectors who visit laboratories bi-annually, the inspectors will generally review general and specific operations checklist items. Results of all internal audits and inspections, in addition to copies of certification renewals, are provided to the Libby laboratory coordinator (CDM Smith) and are placed into the contract files.

4.9 Laboratory Contamination Monitoring

Laboratory monitoring for the occurrence of contamination is a continual process that covers every aspect of the laboratory process. Laboratory blanks serve as a check for asbestos contamination of laboratory tools and equipment. If asbestos is detected, corrective actions are implemented, including wipe downs of equipment and work areas and an attempt to isolate the source of contamination. Corrective actions continue until follow-up laboratory blank results are negative for asbestos. Section 8.1 presents the results for all laboratory blanks collected under the Libby program.

In addition, each analytical laboratory also performs monthly air and dust monitoring to evaluate worker safety and ensure laboratory cleanliness in compliance with their SOPs and certification requirements. If any asbestos is detected, corrective action is taken, including a cleanup of the laboratory area by HEPA vacuum and or wet-wiping. The laboratory will also attempt to isolate the source of contamination to minimize the potential of repeat contamination. Although results for these monitoring samples are maintained at each laboratory and are available for review during an on-site audit, only air and dust monitoring samples from the Mobile Lab in Libby that were collected by CDM Smith are recorded in the Libby database. Hard copies of air and dust monitoring samples as collected by EMSL Analytical at the Mobile Lab as part of their QA/QC program are sent to the Libby laboratory contractor (CDM Smith) on a monthly basis as information for this dedicated project facility.

Table 4-3 summarizes the results of the air and dust samples collected by CDM Smith to monitor potential laboratory contamination at the Mobile Lab in Libby. Air and dust monitoring samples have been routinely collected since 2002. As seen, LA was detected in more than 20% of the personal air and dust monitoring samples collected in 2002. Since 2002, no asbestos has been detected in any dust monitoring sample[4], and LA has been rarely detected in the air monitoring samples analyzed by TEM (only 4 of 288 samples, 1.4%).

[4] Collection of dust monitoring samples ceased in 2007.

Section 5
Libby Database Quality Assurance

The Libby project database is a custom relational database that has been developed specifically for the Libby site. Due to the nature of asbestos analysis and other data requirements, the database has been developed iteratively, expanding in its capabilities (and complexity) as project-specific needs have evolved. In addition to providing new functionality, as needed, enhancements have been made to accommodate data user needs and to incorporate various automated QA/QC procedures to improve data integrity.

5.1 Data Management Applications

5.1.1 Libby Project Database

In the early stages of the Libby project, field sampling data were maintained on paper and laboratory results were managed in Microsoft Excel® spreadsheets. As the project continued, it became necessary to create a central repository to store all sample and result information so that results could be quickly retrieved. The first centralized database (referred to as Libby1) was a Microsoft Access® database with a data entry application. This database was not designed to capture the full level of detail that was soon found to be needed by data users (e.g., raw asbestos structure data generated during TEM analyses). The Libby1 database also had few integrity checks, thus some errors and inconsistencies in field sample and analytical results were not addressed prior to incorporation into the project database.

As the large scope of the project and the complexity of user needs became better understood, a more robust project database was developed to accommodate the project needs. This new database is referred to as Libby2. The Libby2 database is a Structured Query Language (SQL) server database with several data entry applications and numerous data integrity constraints to ensure that the resulting project database is as complete and accurate as possible.

At the beginning of 2002, the Libby1 database was transferred to the Libby2 database. At the time of the data migration, any records that did not conform to the new integrity checks were modified and corrected as needed. As part of the integrity checks, it was required that each sample must have an appropriate COC record and that all results were connected to a sample record. Full documentation of the migration process, including before and after copies of the database, is maintained on the Libby SQL server. All FSDSs, COC forms, and analytical results EDDs were also standardized at this time.

The Libby SQL server also houses the Development database and the Test database (see Section 5.5). The Development and Test databases are used only in the development and testing of new applications prior to incorporation into the Libby2 database, thus insuring the integrity of the Libby2 database.

Because data are continually being generated as a result of ongoing sampling and analysis at the Libby site, the Libby2 database is a dynamic database. Each day, new property, sample, analysis, and results records are added, and records are corrected, as appropriate. As a result, any database-generated queries, maps, and reports provide only a "snapshot" of the database on the day the output was created. **Appendix B** provides a snapshot of the Libby2 database[5] (in a Microsoft Access® database format) as of December 8, 2009. This snapshot was used to prepare all data summaries included in this report. This appendix also includes a summary of data reduction methods as well as any findings from the cursory data review performed to identify data omissions, unexpected values, or apparent inconsistencies in the QC results.

5.1.2 Other Applications

In addition to the main Libby project database, there are several other applications that have been developed to assist in project data management at the Libby site:

eLASTIC. The eLASTIC database began as a simple sample tracking tool in Microsoft Access® that was utilized by the Libby field sample coordinator. In 2002, the eLASTIC database was expanded to allow input of FSDS, property, and COC information. In addition, this application was modified to prepare electronic COCs. There are two versions of the eLASTIC database – one for use by the field (referred to as Field eLASTIC) and one for use by the CSF (referred to as CSF eLASTIC). Field sample and soil preparation data are transmitted electronically from eLASTIC directly into the Libby2 database.

Analytical EDDs. Each analytical method utilized at the Libby site has a unique analytical EDD that has been developed for the reporting needs of the Libby site to ensure consistency between laboratories in the presentation and submittal of analytical data. All Libby laboratories are required to use these analytical EDDs when providing results. Results from the analytical EDDs are uploaded directly into the Libby2 database.

Libby GIS Server. The Geographic Information System (GIS) server is an interactive web-based server located outside the EPA firewall, thus enabling any user with a valid user ID and password access to the server. The GIS server was installed in 2003.

Libby eRoom. The Libby eRoom is a web-based collaborative workspace that enables all invited members of the Libby project team to post and view site reports and documentation. The Libby eRoom is managed by CDM Smith, and only those team members with valid user ID and password are allowed access to the Libby eRoom.

[5] This database snapshot is restricted to the subset of data tables utilized in this report.

TEM Consolidated Database. The TEM Consolidated Database was an early (2001-2002) interim Microsoft Access® database developed and utilized by SRC, Inc., in support of risk assessment. This database provided a summary of the raw structure data generated during TEM analyses of air and dust samples, because the Libby1 database did not provide these detailed results. Because the Libby2 database was modified to include the TEM raw structure data, the TEM Consolidated Database is now obsolete.

5.2 Documentation and Administration

Day-to-day operational control of the Libby2 database is under the control of EPA Region 8 staff, including physical and network security, access rights, server cleanup, and data backup. Incremental backups of the Libby2 database are performed daily Monday through Thursday, and a full backup is performed on Friday. The full backup tapes are stored off-site for 30 days. After 30 days, the tape is placed back into the tape library to be overwritten by another full backup.

All database-related documents and the source code for database applications are maintained on the Volpe Libby server. Current documentation is also maintained in the Libby eRoom. All changes to the structure of either the Libby2 database or the eLASTIC database are tracked with a request number and recorded in the Libby eRoom. Database corrections to property, sample, analysis, and/or results information are documented through email tracking, by noting appropriate corrections on hard copy documentation (e.g., FSDSs, COCs), and maintaining revised versions of analytical EDDs.

5.3 Security

The Libby2 database server is located at the EPA Region 8 facility and resides on the EPA network behind EPA firewalls. Data users may access the Libby2 database server via the EPA-approved virtual private network (VPN). All access to the server is restricted and controlled by EPA and Volpe. All personnel requiring access to the Libby2 database server must pass an EPA security quiz and be approved by the EPA Database Project Manager, before being provided with a VPN user ID and password.

Within the EPA local area network (LAN), authorized users may access the Libby2 database through the LAN connection. Outside the EPA LAN, authorized users may access the database through the EPA SecuRemote application. EPA provides authorized users with a unique SecuRemote user ID and password. The SecuRemote password expires automatically every 90 days and must be renewed.

5.4 Data Entry and Management Processes

The Libby2 database, application development, and data entry are managed by Volpe. All electronic data provided to Volpe is sent via a dedicated Libby email account. This email account may be accessed by all Volpe data entry staff, thus ensuring that data entry into the Libby2 database is not dependent on any one individual. The data entry process is a primarily automated process. The following applications are utilized by the data entry staff to load data into the Libby2 database:

- **Sample Load Program**: This application automatically loads the partial sample characteristic information from the Field eLASTIC database into the Libby2 database. Any sample information not captured in the Field eLASTIC database is manually entered by Volpe data entry personnel (see "Libby2 Data Entry Program" bullet below).

- **COC Load Program**: This application automatically loads the COC information from the Field eLASTIC database into the Libby2 database.

- **Survey Load Program**: This application automatically loads a portion of the field survey information from Excel exports from the Field eLASTIC database into the Libby2 database. Any survey information not captured in the Field eLASTIC database is manually entered by Volpe data entry personnel (see "Libby2 Data Entry Program" bullet below). *Note: Not all survey information is captured in the Libby2 database, but complete hard copy survey results are stored in the CDM Smith field office in Libby.*

- **Property Status and Access Load Program**: This application automatically loads the field property status and access information from the Field eLASTIC database into the Libby2 database.

- **CSF Load Program**: This application automatically loads the soil sample preparation and COC information from the CSF eLASTIC database into the Libby2 database.

- **EDD Load Program**: This application automatically uploads the various analytical EDDs provided electronically from the analytical laboratories into the Libby2 database. This load program performs several integrity checks to ensure that records are consistent with existing results prior to uploading analytical data. For example, this application verifies that air volume and dust area reported in the analytical EDD are consistent with values as reported in the sample FSDS (i.e., within 1 liter or 1 square centimeter). If issues are identified, the analytical EDD will not be uploaded until they are rectified.

- **GIS Load Program**: This application automatically loads GIS data from eLASTIC into the Libby2 database.

- **Libby2 Data Entry Program**: This application provides standardized data entry forms for recording information from FSDSs, PSDSs, COCs, and property surveys. These forms are used by Volpe to manually enter data not captured in the Field or CSF eLASTIC databases into the Libby2 database. These data entry forms have a variety of built-in QC functions that improve accuracy of data entry and help maintain data integrity (e.g., drop-down menus). Once all required information has been entered, an independent data entry reviewer checks all data entry items against the hard copy forms. If any issues are identified, the reviewer immediately corrects any mistakes and provides feedback to the data entry personnel regarding the issue identified to prevent future errors.

5.5 Testing Procedures

As needed, the Libby2 database reports, data entry forms, and load programs are updated to accommodate the changing needs of the data users. Standardized testing procedures are in place for application, database, and form modifications. All modifications are first developed on the Development database (which is kept separate from the Libby2 database) to ensure that any changes are working correctly prior to transfer to the Test database where the data entry and data quality team perform additional testing. Once all modifications are tested and working correctly, they are then transferred to the Libby2 database.

Prior to implementing any changes to the eLASTIC database EDDs and analytical EDDs utilized by the load programs, the revised EDDs are tested against the load programs before being used by the field teams or laboratories to ensure that modifications do not impact the load programs or result in failures of the data integrity checks.

5.6 Data Package Review

The PLM analysis method used at the Libby site has been customized to meet project-specific needs and reporting requirements. To ensure that all analytical labs were reporting data in accordance with these requirements, between December 2002 and December 2003 the EPA laboratory contractor (CDM Smith) reviewed a subset of all PLM-VE and PLM-Grav laboratory data packages.

Three sample delivery group packages (SDGs) per laboratory per method for two time periods (December 2002 to June 2003 and July 2003 to December 2003) were randomly chosen for review. A total of 32 PLM-VE and 30 PLM-Grav laboratory data packages were selected for data review. A detailed description of the data packages reviewed can be found in CDM Smith (2005).

Each package was evaluated for overall completeness using a standardized checklist that included the following information:

- Number of samples received

- Date of sample receipt and condition of samples

- SDG case narrative
- Check for contamination (daily)
- Verification of the refractive indices of the refractive index liquids once per month
- Verification of microscope adjustments prior to each SDG
- Hard copy data forms (as presented in the EDD spreadsheet)
- Bench sheets for data results

During the data review, some deficiencies were noted in individual SDGs. However, all issues were considered minor (i.e., did not result in erroneous PLM results) and no trends were observed (i.e., there were no recurring problems with a particular laboratory or checklist item). All issues identified during the review were resolved by the laboratories. Details regarding the PLM data package review can be found in CDM Smith (2005).

The practice of performing regular data package reviews continued from December 2003 through the period of this report (December 2009). It was standard practice for CDM Smith to review, at a minimum, the items listed for PLM, AHERA, and ISO analyses. A comparison between the COC, LIMS report, and EDD was performed, as well as verification that reporting/stopping rules were correctly applied.

5.7 Database Review and Verification

Prior to the preparation of any data summary reports, a cursory data review is performed on any applicable data in the Libby2 database to identify data omissions, unexpected values, or apparent inconsistencies. A more thorough data verification evaluation may also be performed to ensure the consistency and quality of reported data.

Data verification involves comparing the electronic data in the Libby2 database to information on the original hard copy FSDS form and on the original hard copy analytical bench sheets. In addition, calculations of sample air volume, analytical sensitivity, and structure counts are checked. Any omissions or apparent errors identified during the verification are submitted to the field teams and/or analytical laboratories for resolution and rectification in the Libby2 database and on the hard copy documentation.

There have been several data verification evaluations of the Libby2 database. Most of these data verification efforts have been associated with specific site investigations. **Table 5-1** summarizes the main data verification evaluations of the Libby2 database that have been conducted through December 2009. Detailed results of data verification efforts and data quality conclusions for each investigation are provided in the respective verification summary reports. In brief, error frequencies tended to be

higher for older (pre-2002) samples, which were collected and analyzed before many of the Libby-specific standard data recording forms and EDD spreadsheets were developed, and before the Libby2 database load programs were established. Error frequencies tended to be higher following particular programmatic changes (e.g., changing the aspect ratio criterion from 5:1 to 3:1, requiring the recording of structure-specific information on sodium and potassium EDS peaks) and at the beginning of sampling investigations. The frequency of critical errors (i.e., those that would influence LA results) was low.

Section 6
Field Quality Control Evaluation
6.1 Air and Dust Quality Control Samples

There are three types of field-based QC samples for air and dust that are collected and submitted to the laboratories for analysis by TEM and/or PCM:

Lot Blank - This is a filter cassette that has been taken from a new, unused box of filter cassettes. Lot blanks are collected to ensure that sample filter cassettes do not have any asbestos contamination prior to their use in the field. Early in the Libby sampling programs, lot blanks were collected at a frequency of 1/50 (2%). Effective May 21, 2007 (per LFO-000106), the lot blank collection frequency was decreased to 1/500 (0.2%) for air cassettes and 1/300 (0.3%) for dust cassettes. LFO-000106 collection rates apply to all sampling programs. If asbestos structures are observed on the lot blank during analysis, the entire box of filter cassettes is discarded.

Field Blank - This is a filter cassette that is taken to the field and treated in the same manner as cassettes used for collection of air or dust samples, except that no air is drawn through the cassette. Field blanks serve as an indicator of potential contamination that may occur during collection and handling of field samples. Most field blank samples for air are prepared for analysis using a direct preparation, while field blank samples for dust are prepared using an indirect preparation. The target rate for air and dust field blank collection is usually specified in the appropriate project-specific field guidance document(s). Typically, one field blank is collected per sampling team for each day when activities are conducted. If one or more LA structures are observed in a field blank, a data qualifier is applied to the related field samples (i.e., field samples collected by the same team on the same day) to indicate potential contamination.

Field Duplicates[6] - These are independent samples of environmental medium collected at the same location and at the same time as the primary sample. These samples are collected independent of the original field sample with separate sampling equipment. Field duplicates help to evaluate the inherent variability of sample results due to small-scale variability in concentration as well as measurement error in sample analysis. Because this variability is random and may be either small or large, typically, there is no quantitative requirement for the agreement of field duplicates. Field duplicates have not been collected routinely at the Libby site, but have been collected as part of specific sampling investigations.

[6] The term "field replicate" and "field duplicate" have been used interchangeably in the field for air and dust. During the ambient air monitoring program, field duplicates for air were identified as "co-located" samples. For the purposes of this report, replicates and co-located samples will be referred to as field duplicates.

6.1.1 Lot Blanks

Lot blanks are prepared by submitting unused cassettes for analyses prior to putting the group (lot) of cassettes into use. Lot blank results are reviewed by designated CDM Smith staff responsible for the project sample cassette inventory. If the lot is shown to be contaminated with 7 or more fibers per square millimeter (f/mm^2) by PCM or 1 or more LA structures by TEM AHERA, then the lot of cassettes is discarded and a new lot of cassettes is used following lot blank acceptance testing.

TEM Results

Table 6-1 summarizes the total number of TEM lot blank analyses stratified by year (Panel A) and presents the TEM results for these lot blanks (Panel B). As seen, a total of 707 TEM lot blank analyses were performed from 1999 to 2009. The apparently low lot blank collection rate in 2000-2002 is likely a consequence of sample nomenclature recording. Prior to 2003, all lot blank and field blank samples were simply identified as "blank" in the Libby project database[7], and the type of blank sample was usually recorded in the sample comment field. The Libby2 database has since been modified to distinguish between lot blanks and field blanks, and the appropriate designation was back-populated using the sample comment field. However, unless the sample comment explicitly stated that the sample was a lot blank, all samples identified as "blank" were assumed to be field blanks. It is possible that some lot blanks were not explicitly identified as such and hence were classified as field blanks for the purposes of this report. Between 2003 and 2007, the lot blank collection frequency was about 3%, which is consistent with program frequency requirements at that time (2%). In 2008 and 2009, the lot blank collection frequency was about 0.5%, which is slightly higher than the frequency requirements specified in LFO-000106 (0.2%-0.3%).

As seen in Panel B of **Table 6-1**, no asbestos structures have been observed in any lot blank sample. Based on these results, it is concluded that air and dust cassettes utilized during field sample collection at Libby did not have asbestos contamination.

PCM Results

In addition to analyzing the lot blanks by TEM, a subset of lot blanks are also analyzed by PCM. Because PCM cassettes are used for all project air and dust sampling activities (conducted by CDM Smith or its subcontractors), both analyses are performed so that there is comparable lot blank results for each analytical method. If the fiber loading rate for a lot blank analyzed by PCM is higher than the background fiber loading rate of 7 f/mm^2 specified in NIOSH 7400, a data qualifier may applied to the related field samples (i.e., field samples collected by the same team on the same day) to indicate potential contamination.

A total of 473 lot blanks have been analyzed by PCM. **Table 6-2** summarizes the total number of PCM lot blank analyses stratified by year (Panel A) and presents the PCM results for these lot blanks (Panel B). Between 2003 and 2007, the lot blank collection

[7] The specific sample IDs of lot blanks and field blanks were recorded in the field logbooks, thus it was not necessary for the database to record this information.

frequency ranged from 6-15%, which is higher than the program frequency requirements at that time (2%). In 2008 and 2009, the lot blank collection frequency ranged from 0.7%-0.9%, which is also higher than the frequency requirements specified in LFO-000106 (0.2%-0.3%).

PCM fiber loading rates for lot blanks are shown graphically in **Figure 6-1**. As seen, none of the PCM lot blanks analyzed had a loading rate above the background loading rate of 7 f/mm^2 specified in NIOSH 7400. The Libby-specific mean background fiber loading rate across all PCM lot blank analyses was 0.29 f/mm^2. Based on these results, it is concluded that PCM air cassettes utilized during field sample collection at Libby did not have significant contamination.

6.1.2 Field Blanks

TEM Results

Table 6-3 summarizes the total number of TEM field blank samples collected by year (Panel A) and presents the TEM results for these field blanks (Panel B). A total of 6,387 field blank samples were collected and analyzed by TEM from 1999 to 2009. Only 8 field blank samples (0.1% of all field blanks) have had detectable LA structures observed. For four of these eight field blanks, TEM results are also available for an additional field blank sample that was collected by the same field team at the same property on the same day as the field blank of interest. In all four cases, no LA structures were observed in any of the concurrent field blanks. This suggests that the presence of LA in these four field blanks may not be a reflection of contamination associated with field collection techniques. Nevertheless, in cases where LA structures were observed, interpretation of TEM results for any associated field samples (i.e., field samples collected on the same day by the same team) should consider the elevated LA loading rates in the field blanks. The associated field samples should be flagged as "FB" in the database to alert data users to this potential issue.

Sample coordination staff reviewed results of field blanks and would notify the appropriate field team leader of potential sample collection/handling issues if elevated LA loading rates were discovered in field blanks. Field team leaders would then discuss with/retrain sampling staff on proper sampling techniques. On very rare occasions, it was discovered that a field sample and field blank were mislabeled. In these cases, when the transposition was evident, sample and COC information was corrected. No LA structures have been observed in any field blank sample since September 2002. Based on these results, it is concluded that field contamination of sample collection filters is not of concern.

PCM Results

Table 6-4 summarizes the total number of PCM field blank samples collected by year (Panel A) and presents the PCM results for these field blanks (Panel B and Panel C). A total of 2,161 field blank samples have been collected and analyzed by PCM. **Figure 6-2** (Panel A) presents the PCM results for field blanks as a function of the sample collection date. As seen, there are five field blank samples that have unexpectedly

high filter loading rates relative to the other field blanks (these samples are circled in the figure). These five "suspect" samples account for nearly half of all PCM fibers observed in field blanks. Upon review of the detailed sampling information for these samples (e.g., field logbooks, co-located field samples, co-located field blanks), it is possible that some of these samples may have actually been field samples that were misidentified. **Figure 6-2** (Panel B) presents the results for all field blanks excluding these five samples.

Table 6-4 presents summary statistics for PCM field blanks, both with (Panel B) and without (Panel C) the five suspect samples. After exclusion of the five suspect samples, only 20 field blanks (<1%) have a filter loading rate above the background loading rate of 7 f/mm^2 specified in NIOSH 7400, and only one PCM field blank has exceeded the NIOSH 7400 background loading rate since November 2002. In cases where the field blank results exceeded the NIOSH 7400 background loading rate, interpretation of PCM results for any associated field samples (i.e., field samples collected on the same day by the same team) should consider the elevated loading rates reported in the field blanks. The associated field samples should be flagged as "FB" in the database to alert data users to this potential issue.

The mean background loading rate across all PCM field blank analyses from the Libby site (excluding the five suspect samples) was 0.29 f/mm^2. This background loading rate is similar to the rate observed in PCM lot blanks. Based on these results, it is concluded that field collection methods for PCM samples were unlikely to introduce significant contamination.

6.1.3 Field Duplicates

At the Libby site, field duplicates of air and dust are not collected routinely, but have been collected as part of some sampling investigations. The result for the original and field duplicate samples are compared using the method for comparison of two Poisson rates described by Nelson (1982).

Table 6-5 summarizes the detailed results for all field duplicate samples collected and analyzed by TEM. A total of 73 air field duplicate samples and 22 dust field duplicate samples have been collected and analyzed by TEM across eight different sampling programs from 2000 to 2008. Three original-duplicate pairs were statistically different at the 90% confidence interval (CI).

Table 6-6 summarizes the detailed results for all field duplicate samples collected and analyzed by PCM as part of two programs (Phase 2 in 2001 and Stimson Lumber in 2002). A total of 13 air field duplicates were collected and analyzed by PCM. As seen, only one of the original-duplicate pairs was statistically different at the 90% CI.

Because the overall agreement for field duplicate samples for both TEM and PCM is good, it demonstrates that variability due to small-scale heterogeneity and analytical measurement error is minimal and that air and dust sample results tend to be reproducible and reliable.

6.2 Soil Quality Control Samples

As described previously in Section 2.5, there are four types[8] of field-based QC samples for soil that were collected and submitted to the laboratories:

Field Splits - A field split is an aliquot of a field sample that is taken after the soil sample (often a composite) has been collected and mixed. As the name indicates, creation of the field split generally occurs in the field. A field split helps to evaluate the precision of the subsequent laboratory preparation and analysis steps. Following an EPA field audit in August 2002, field duplicate samples replaced field split samples as a measure of field variability for soil (see LFO-000057). Typically, there is no quantitative requirement for the agreement of field splits or field duplicates.

Field Duplicates - A field duplicate is a second soil sample that is co-located with the original field sample. These samples are collected independent of the original field sample with separate sampling equipment from a location immediately adjacent to the original field sample. Field duplicates serve to evaluate the inherent variability of soil sample concentration values over a small spatial scale.

Rinsate - A rinsate is an aqueous sample that is collected by rinsing decontaminated field equipment with de-ionized water. Rinsates determine if decontamination procedures of field equipment are adequate to prevent cross-contamination of samples during sample collection. Rinsates were only utilized for a short time in 2002, after which field equipment blanks (see below) replaced rinsates as a measure of potential contamination.

Field Equipment Blanks - A field equipment blank is a sample of silica sand that has come into contact with decontaminated field equipment. Field equipment blanks are collected to determine if decontamination procedures of field equipment are adequate to prevent cross-contamination of samples during sample collection.

6.2.1 Field Splits

A total of 648 field splits for soil were collected and analyzed by PLM from 1999 to 2002 (see **Table 6-7**). Collection frequencies for field splits have differed somewhat between investigations, but the target collection frequency for field splits was usually about 1 per 20 soil field samples (5%). As noted above, field split samples were replaced by field duplicate samples starting in August 2002.

Table 6-8 (Panel A and Panel B) presents a comparison of the original sample results to the field split results when both the original and the field split were analyzed by the same method (either NIOSH 9002 or PLM-VE, respectively). **Table 6-8** (Panel C) presents a comparison of the original sample results to the field split results when the

[8] The Libby2 database also includes several historic samples where the field QC type is classified as "Trip Blank" or "Field Blank." Trip blanks are soil samples collected in support of volatile organic compound analysis. Field blanks are equivalent to equipment blanks and results for these samples are presented in the Field Equipment Blank section (Section 6.2.4).

original and reanalysis were performed using different methods (i.e., original sample was analyzed by NIOSH 9002 and the field split was analyzed by PLM-VE). In this table, results are ranked as concordant if both the original sample result and the field split result report the same semi-quantitative classification (concordant pairs are shaded in gray). Results are ranked as weakly discordant if the original sample result and the field split result differ by one semi-quantitative classification (e.g., Bin A vs. Bin B1). Results are ranked as strongly discordant if the original sample result and the field split result differ by more than one semi-quantitative classification (e.g., Bin A vs. Bin B2).

As seen in **Table 6-8**, concordance was generally good (about 80-90%) both within and across PLM methods. When samples were discordant, results were usually only weakly discordant, with the incidence of strongly discordant values being quite low (i.e., only two field splits are ranked as strongly discordant). The discordant results between splits are probably due to measurement error in the PLM analysis, but there may also be some contribution from residual heterogeneity between split samples.

These results support the conclusion that, while there is inherent analytical uncertainty associated with PLM visual area estimation techniques, soil sample results are generally reproducible and reliable and are not greatly influenced by differences in laboratory preparation and analysis techniques.

6.2.2 Field Duplicates

A total of 819 field duplicates were collected and analyzed by PLM from 1999 to 2009 (see **Table 6-9**). Field duplicates for soil were collected for all phases of investigation work in Libby. Collection frequencies have differed somewhat between investigations, but the target collection frequency for field duplicates was usually about 1 per 20 investigative soil field samples (5%).

Table 6-10 (Panel A and Panel B) presents a comparison of the original sample results to the field duplicate results when both the original and the duplicate were analyzed by the same method (either NIOSH 9002 or PLM-VE, respectively). **Table 6-10** (Panel C) presents the results when the original and the duplicate were analyzed by different methods.

Results for field duplicate analyses are evaluated using the same concordance ranking method described above. As seen in **Table 6-10**, overall concordance was generally good (about 87%) within PLM methods, and similar to the concordance rates for field splits. Concordance was lower across PLM methods, but this may be a consequence of the low number of samples evaluated. When field duplicates were discordant, results were usually only weakly discordant, with the incidence of strongly discordant values being quite low (i.e., only seven field duplicates are ranked as strongly discordant). While discordances between soil field duplicates may occur due to analytical variability and authentic spatial variation between the original and field duplicate sampling location, the fact that concordance rates for field duplicates and field split were similar suggests that variation from spatial heterogeneity is likely to be small.

These results support the conclusion that estimates of soil concentration by PLM are generally reproducible and reliable, and are not greatly influenced by potential differences in field collection methods, small-scale spatial variability, or laboratory preparation and analysis techniques.

6.2.3 Rinsates

A total of 20 rinsates have been collected at the Libby site (18 during the 2002 CSS sampling; 2 during a 2008 geological characterization study). These aqueous samples were analyzed by TEM using EPA Method 100.2. **Table 6-11** presents the detailed results for each rinsate sample. As seen, a single LA structure was observed in two rinsates, and all other rinsates were non-detect for asbestos. These results suggest that decontamination procedures for field equipment were generally adequate. However, it is not possible to interpret the potential implication of a single LA structure measured in a rinsate by TEM to an associated contamination level for a soil sample measured by PLM visual area estimation. Because of this, it was determined that the collection of additional rinsate samples during subsequent CSS activities was not necessary and that field equipment blanks would serve as the measure of the effectiveness of soil sampling equipment decontamination. This programmatic change was documented in Revision 1 of the *CSS SAP* (CDM Smith 2004a).

6.2.4 Field Equipment Blanks

The collection of field equipment blanks began in May 2002 as part of the CSS sampling. Field equipment blanks are routinely collected as part of all investigative and cleanup activities.

Prior to the collection of any field equipment blanks, "lot blanks" of the silica sand used in the collection of field equipment blanks were submitted to the laboratory for PLM analysis by NIOSH 9002 to ensure that the sand did not contain asbestos. To date, two lot blanks have been collected (one in May 2002 at the beginning of the CSS and one in September 2005). No asbestos was observed in either of these lot blank samples.

A total of 316 field equipment blanks have been collected since May 2002 and analyzed by PLM (i.e., NIOSH 9002 and/or PLM-VE). With the exception of two samples, the results for all field equipment blanks were non-detect for asbestos. In both cases where the field equipment blank was a detect, the PLM-VE result for LA was reported as trace (i.e., Bin B1, detected at levels lower than the 0.2% LA reference material). Any field samples associated with these two field equipment blanks (i.e., field samples collected on the same day by the same team) should be flagged as "EB" in the database to alert data users to this potential issue. No field equipment blank has had detectable levels of asbestos since May 2003.

Based on these results, it is concluded that decontamination procedures for soil sampling equipment were adequate and unlikely to introduce LA contamination that would result in a quantifiable impact on soil results analyzed by PLM.

Section 7
Close Support Facility (CSF) Quality Control Evaluation

The CSF QC samples are used to ensure that the preparation techniques utilized to process soil samples at the CSF did not introduce potential contamination and to evaluate variability associated with preparation techniques.

There are two types of CSF QC samples that were evaluated at the Libby site:

Preparation Blank – A preparation blank consists of asbestos-free quartz sand that is processed with each batch of field samples. A batch of samples is defined as a group of samples that have been prepared together for analysis at the same time (approximately 125). Preparation blanks determine if cross-contamination is occurring during sample preparation processing (i.e., drying, sieving, grinding, and splitting). Two types of soil preparation blanks were evaluated:

> ***Drying Blanks***[9]*.* A drying blank consists of approximately 100 to 200 grams of asbestos-free quartz sand that is processed with each batch of field samples that are dried together (usually this is approximately 125 samples per batch). The drying blank is then processed identically to field samples. Drying blanks determine if cross-contamination between samples is occurring during sample drying.
>
> ***Grinding Blanks****.* A grinding blank consists of asbestos-free quartz sand and is processed once per day, on days that field samples are ground. Grinding blanks determine if decontamination procedures of CSF laboratory equipment used for sample grinding and splitting are adequate to prevent cross-contamination.

If asbestos is detected in a preparation blank, a data qualifier may be applied to the related field samples (i.e., field samples prepared in the same batch) to indicate potential contamination.

Preparation Duplicates – Preparation duplicates are splits of field samples submitted for sample preparation. After drying, but prior to sieving, the original field sample is split into two equal aliquots using the riffle splitter. One preparation duplicate is included for every 20 field samples prepared. Comparison of the results for preparation duplicates with the paired original field samples helps to evaluate the variability that arises during the preparation and analysis steps. The variability

[9] Prior to April 2003, drying blanks were referred to as "preparation blanks". A preparation blank, by definition, was intended to be processed with each batch of field samples. Since samples rarely went through the entire sample processing routine together (i.e., drying, sieving, grinding, and splitting), the definition of this preparation QC sample was changed, and the inclusion of a grinding blank was added at this time.

between the preparation duplicate and the associated field sample reflects the combined variation in sample heterogeneity and the variation due to measurement error. Because this variability is random and may be either small or large, typically, there is no quantitative requirement for the agreement of preparation duplicates.

7.1 Preparation Blanks

The incorporation of preparation blanks by the CSF began in early 2002 as part of the CSS sampling program. A total of 959 drying blanks and 1,245 grinding blanks have been analyzed by PLM-VE, with an overall collection frequency of about 5%. **Table 7-1** summarizes the results for each type of preparation blank. With the exception of one drying blank and four grinding blanks, all preparation blanks were non-detect. For the five preparation blanks that were detect, the PLM-VE result for LA is reported as trace (i.e., Bin B1, detected at levels lower than the 0.2% LA reference material). Any field samples associated with these five preparation blanks (i.e., field samples prepared in the same batch) should be flagged as "PB" in the database to alert data users to this potential issue. The observed detects have occurred over a wide time span (2003-2007) which suggests that this potential contamination issue is not related to a single discrete event.

Based on these results, it is concluded that preparation methods at the CSF were unlikely to introduce LA contamination that would result in a quantifiable impact on soil results analyzed by PLM-VE.

7.2 Preparation Duplicates

The incorporation of preparation duplicates by the CSF began in June 2002 as part of the CSS sampling program. A total of 1,420 preparation duplicates have been analyzed by PLM-VE, with an overall collection frequency of about 5%, which is consistent with the required frequency rate (1 per 20 samples, 5%). **Table 7-2** presents a comparison of the original sample results to the preparation duplicate results. Results are ranked as concordant if both the original sample result and the preparation duplicate result report the same semi-quantitative classification (concordant pairs are shaded in gray). Results are ranked as weakly discordant if the original sample result and the preparation duplicate result differed by one semi-quantitative classification (i.e., Bin A vs. Bin B1). Results are ranked as strongly discordant if the original sample result and the preparation duplicate result differed by more than one semi-quantitative classification (i.e., Bin A vs. Bin B2).

As seen, overall concordance was generally good (greater than 90%). When results were discordant, the original sample result and the preparation duplicate result were usually only weakly discordant. Slight differences between aliquots of the same sample are expected due the inherent heterogeneity of soil samples. There were five samples where the original sample result and the preparation duplicate result were strongly discordant.

These results support the conclusion that the soil sample results are generally reproducible and reliable and are not greatly influenced by differences in laboratory preparation and analysis techniques.

Section 8
TEM Laboratory Quality Control Evaluation

The following types of QC analyses were performed by each of the participating TEM laboratories:

Laboratory Blanks – This is an analysis of a TEM grid that is prepared from a new, unused filter by the laboratory and is examined using the same procedure as used for field samples.

Recount Same – This is an analysis of a TEM grid that is re-examined by the same microscopist who performed the initial examination. The microscopist examines only the same grid openings as were counted in the original examination.

Recount Different – This is an analysis of a TEM grid that is re-examined by a different microscopist than who performed the initial examination. The microscopist examines only the same grid openings as were counted in the original examination.

Verified Analysis – This type of QC analysis is similar to a Recount Different but has different requirements with regard to documentation[10]. A verified analysis must be recorded in accordance with the protocols provided in NIST (1994).

Interlab – This is an analysis of a TEM grid that is re-examined by a microscopist from a different laboratory than who performed the initial examination. The microscopist examines only the same grid openings as were counted in the original examination.

Repreparation – This is an analysis of a TEM grid that is prepared from a new aliquot of the same field sample as was used to prepare the original grid. Typically, this is done within the same laboratory that performed the original analysis, but a different laboratory may also prepare grids from a new piece of filter. If the repreparation is done within the same laboratory, the repreparation and re-analysis should be done by a different analyst than who read the original, whenever possible.

PE standards (samples with known concentration levels) were not employed for TEM because no suitable certified standards for amphibole asbestos were available for air or dust.

The Libby Laboratory Modification LB-000029B identifies program-wide goals for the interpretation of laboratory-based QC samples for TEM. The criteria established in

[10] About 5% of all verified analyses were performed as a third analysis following the completion of a recount same or recount different analysis. The purpose of this third analysis was to resolve any apparent inconsistencies between the original and the recount analyses. For the purposes of this report, the evaluation of verified analyses does not include these third analyses.

LB-000029B are used herein to assess the laboratory QC samples analyzed at the Libby site.

8.1 Laboratory Blanks

In general, one laboratory blank is included as part of every analytical laboratory job. Therefore, the overall analysis frequency will depend upon the number of samples included in each laboratory job, which may vary between laboratories. As specified in LB-000029B, the minimum frequency[11] for the analysis of laboratory blanks is 4% and the overall program-wide assessment criteria for laboratory blanks are as follows:

Metric	Program-Wide Assessment		
	Good	Acceptable	Poor
% with ≥ 1 asbestos structures	0% - 0.1%	0.2% - 0.5%	>0.5%

A total of 2,023 TEM laboratory blank analyses have been performed from 1999 through December 2009. **Table 8-1** (Panel A) summarizes the frequency of laboratory blank analyses for each TEM laboratory by year. As shown, the program-wide laboratory blank frequency from 1999 to 2009 was 4.0%. With the exception of one laboratory[12] (Batta Laboratories, Inc.), laboratory blank analysis frequencies for each laboratory have usually met or exceeded the frequency requirements specified in LB-000029B.

Table 8-1 (Panel B) presents the results for all TEM laboratory blank analyses. No amphibole structures (LA or other amphibole [OA]) have been observed in any laboratory blank sample. Chrysotile structures have been observed in four laboratory blanks from EMSL Analytical. No chrysotile structures have been observed in any laboratory blank since December 2005. The percentage of laboratory blanks with one or more asbestos structures is 0% for amphibole asbestos and 0.2% for chrysotile. These results rank as "good" and "acceptable," respectively, based on the program-wide assessment criteria specified above. Based on these results, it is concluded that the TEM preparation and examination procedures utilized within the analytical laboratories did not introduce LA contamination.

8.2 Recount Analyses

8.2.1 Evaluation Criteria

For recount same, recount different, and verified analyses, comparisons to the original analysis were evaluated on a grid opening-by-grid opening and structure-by-

[11] The minimum lab blank frequency requirements specified in LB-000029B first became effective in 2003.
[12] Based on discussions with a senior analyst from Batta Laboratories, Inc., lab blanks were analyzed routinely, but results were not transmitted via EDD for inclusion in the Libby2 database.

structure basis. Only those grid openings that were able to be re-examined[13] were included in this evaluation. As specified in the LB-000029B, there are three metrics evaluated to assess the degree of agreement (concordance) for LA structures between recount analyses:

- **Total Number of LA Structures –** For grid openings with 10 or fewer structures, total LA structure counts must match exactly to be considered concordant. For grid openings with more than 10 LA structures, counts must be within 10% to rank as concordant.

- **Mineral Class –** There must be 100% agreement on mineral type (chrysotile vs. amphibole) to be considered concordant. Within the amphibole assignment, there must be at least 90% agreement on the assignment of LA and OA types to be considered concordant.

- **LA Structure Dimensions –** Structure dimension concordance is evaluated for LA structures only. For LA fibers and bundles, structure length and width must be within 0.5 µm or 10% (whichever is less stringent) to be ranked as concordant. For LA clusters and matrices, structure length must be within 1 µm or 20% (whichever is less stringent) to be ranked as concordant. There are no rules for width concordance for clusters and matrices.

When considering the results across multiple recount samples, the following program-wide assessment classifications were established:

Metric	Program-Wide Assessment		
	Good	Acceptable	Poor
% concordant on LA count	>95%	85-95%	<85%
% concordant on asbestos type	>99%	95%-99%	<95%
% concordant on LA length	>90%	80%-90%	<80%
% concordant on LA width	>90%	80%-90%	<80%

More than 23,000 grid openings have been re-examined as part of a recount analysis (either recount same, recount different, or verified analysis). Results for all recount grid openings are summarized below. **Appendix C** presents the detailed results for each recount analysis.

8.2.2 Recount Evaluation

Prior to 2007, a large percentage of the grid openings evaluated by recount same, recount different, or verified analysis were non-detect (i.e., the LA structure count was zero) in both the original and the recount analysis. The high frequency of grid openings with no LA structures is a consequence of the fact that samples were

[13] In some instances, grid openings become damaged during the original analysis or during archival and are no longer able to be examined by TEM.

randomly selected for recount analysis before the results of the first analysis were available, and a majority of samples collected at the Libby site are non-detect. Because recounting non-detect grid openings provides limited information on analytical reproducibility, the recount selection procedure was modified in December 2006 (see LB-000029B) to select samples for recount analysis after the original result was obtained (i.e., *post hoc*), preferentially choosing samples that have grid openings with one or more LA structures.

Evaluation Based on Grid Opening Count

Table 8-2 summarizes the grid opening concordance results for recount same analyses (Panel A) and recount different/verified analysis analyses (Panel B). In this table, concordant grid opening pairs are shaded in gray. A total of 23,290 grid openings were re-examined as part of a recount analysis. As seen, most (95%) of the re-examined grid openings were non-detect for LA (i.e., the original analysis did not observe any LA structures in the grid opening). Concordance rates were approximately 99% for recount same analyses and recount different/verified analysis analyses. When LA counts were different between the original and recount analysis, they were usually different by only ± 1 LA structure. Based on the program-wide acceptance criteria specified above, these results rank as good.

When discrepancies were identified in count between the original and the recount analyses, the senior analyst for the laboratory determined the basis of the discordance and took appropriate corrective action (e.g., retraining in counting rules, quantification of size, identification of types, etc). Each laboratory maintains records of all cases of discordant results and of actions taken to address any problems.

Evaluation Based on Individual Structures

A concordance evaluation of individual structures is difficult because detailed sketches of the grid openings re-examined during recount analyses are not available to ensure certain matching of individual structures based on location, orientation, and morphology. However, it is still possible to perform evaluations based on presumptive matches of individual structures. For example, if a single structure is observed in a particular grid opening in both the original and the recount analysis, and the dimensions of the structure are similar in each analysis, it may be presumed that the structure being recorded is the same. Conversely, when a structure is observed in one analysis (either the original or the recount) but not the other, the structure that is observed may be classified as "mismatched."

Table 8-3 (Panel A) summarizes the degree of concordance based on asbestos type, length, and width for presumptive pairs of structures observed in original and recount analyses. A total of 1,415 presumptive structure pairs were evaluated as part of a recount analysis. As seen, the concordance rate is 99% for asbestos type (LA, OA, or C), 84% for length, and 88% for width. Based on the program-wide acceptance criteria specified above, these results rank as acceptable to good.

Table 8-3 summarizes the attributes of structures that were ranked as "mismatches" between the original and the recount analysis (Panel B), and compares them to the attributes of the matched structures (Panel C). As seen, most of the mismatched LA structures are LA fibers. Based on a review of the fiber dimensions (length, width, aspect ratio) of the mismatched structures, there does not appear to be any unique feature that characterizes mismatched structures relative to the matched structure (i.e., the mismatched structures do not appear to be shorter or thinner than the matched structures). This suggests the mismatching is likely to be mainly a random event rather than a systematic error.

8.3 Interlab Analyses

Interlab analyses may be compared in the same way as recount samples (described above). Prior to September 2005, samples for interlab analysis were selected by the Mobile Lab at random prior to the completion of the initial TEM analysis. Two limitations are associated with this process. First, because of the relatively high frequency of non-detects for field samples, there was a high probability for the selection of samples that had no LA structures. Second, because all interlab samples originated from the on-site Mobile Lab, the interlab results did not provide a comprehensive testing of each of the Libby laboratories to each other.

To address these limitations, beginning in September 2005, the procedure for selecting samples for interlab analysis was revised so that the sample selection was *post hoc* (i.e., based on a consideration of the results the initial analysis). This *post hoc* selection procedure allowed for the preferential selection of samples with one or more LA structures observed. In addition, interlab samples were selected so that each of the participating Libby team laboratories was included in the interlab comparisons, both as the originating laboratory and as the location of the interlab analysis[14].

More than 395 grid openings have been re-examined as part of an interlab analysis. Results for all interlab grid openings are summarized below. In some cases, grid openings are damaged during shipment of grids between laboratories, so results below exclude any grid opening that was not able to be examined in both the original and the interlab analysis. **Appendix D** presents the detailed results for each interlab analysis.

Evaluation Based on Grid Opening Count

Table 8-4 summarizes the grid opening concordance results for interlab analyses. In this table, concordant pairs are shaded in gray. As seen, concordance rates were about 74%. When LA counts were different between the original and interlab analysis, they were usually within ±2 LA structures. Based on the program-wide acceptance criteria specified above, these results rank as poor. A review of the interlab results for each

[14] To avoid issues related to proprietary grids, when samples were selected *post-hoc* for interlab analysis, the originating laboratory performed a repreparation using "sharable" grids. The interlab analysis was performed evaluating grid openings from this repreparation, rather than the original analysis.

laboratory (see **Appendix D.1**) did not indicate that differences were due to any one laboratory in particular or that differences were systematic (i.e., Laboratory 'X' usually tended to be higher/lower than the other Libby team laboratories).

Comparison of the results for within-laboratory (recount same, recount different, verified analysis) recounts and between laboratory recounts (interlab) indicate that concordance rates for interlab analyses are lower than those for within-laboratory recount analyses. One hypothesis is that the lower concordance rates may be due to the loss of asbestos structures as a result of transportation between the laboratories (i.e., jostling during shipping caused structures to fall off of prepared grids). In this instance, it is expected that, for a given grid opening, the total number of LA structures observed by the interlab would be lower than the total number of LA structures observed by the original lab. While this may account for some of the count discrepancies, in 60 of 98 grid openings where there is discordance on LA count, the interlab count is higher than the original lab, which suggests that structure loss due to transportation is not an important factor. Another possibility is that transportation resulted in the loss of debris material, thus revealing asbestos structures that may not have been visible in the original analysis. In this instance, the interlab count would tend to be higher than the original lab.

However, the most likely explanation is that there are authentic differences between the analytical laboratories when performing TEM analyses. In an effort to address any potential differences in structure recording practices between laboratories, EPA provided additional clarification on the Libby-specific recording and counting rules for ISO and AHERA/ASTM in LB-000016A and LB-000031A, respectively. EPA also requested that each laboratory review these Libby-specific counting rules and provide a summary of any analyst-specific deviations (documentation of any deviations is attached to each laboratory modification form).

Evaluation Based on Individual Structures

A total of 546 presumptive structure pairs were evaluated as part of an interlab analysis. **Table 8-5** (Panel A) summarizes the degree of concordance on asbestos type, length, and width for presumptive pairs of structures observed in original and interlab analyses. As seen, the concordance rate is 98% for asbestos type, 98% for width, and 84% for length. Based on the program-wide acceptance criteria specified above, these results rank as acceptable to good.

Table 8-5 summarizes the attributes of structures that were ranked as "mismatches" between the original and the interlab analysis (Panel B), and compares these to the attributes of the matched structures (Panel C). As seen, most of the mismatched LA structures are LA fibers. Based on a review of the fiber dimensions (length, width, aspect ratio) of the mismatched structures, there may be tendency for mismatched structures to be slightly shorter than matched structures, but there does not appear to be any other unique feature that characterizes mismatched structures. This suggests the mismatching is likely to be mainly a random event rather than a systematic error.

In an effort to improve the structure matching process to allow for a more robust evaluation of structure concordance, EPA modified the interlab procedures in LB-000029B to include grid opening sketches of structure locations. Therefore, matching structures within a grid opening for the purposes of evaluating concordance will no longer be based on presumptive pairs. In addition, these sketches can be used as part of corrective actions.

8.4 Repreparation Analyses

Repreparation samples are compared based on the estimated concentration values only, using the ratio method for statistical comparison of two Poisson rates recommended by Nelson (1982). As specified in LB-000029B, the minimum frequency[15] for the analysis of repreparations is 1% and the overall program-wide assessment criteria for repreparations are as follows:

Metric	Program-Wide Assessment		
	Good	Acceptable	Poor
% not statistically different at the 90% CI	>95%	90-95%	<90%

A total of 916 TEM repreparation analyses have been performed from 1999 through December 2009. **Table 8-6** (Panel A) presents the frequency of repreparation analyses for each TEM laboratory. As shown, the program-wide repreparation frequency from 1999 to 2009 was 1.8%. With few exceptions, repreparation analysis frequencies for each laboratory have usually met or exceeded the frequency requirements specified in LB-000029B.

Table 8-6 (Panel B) summarizes the results for repreparations. Of the 916 repreparations performed, 884 (96%) were not statistically different at the 90% CI. **Figure 8-1** illustrates the repreparation results in a graphical format. Based on the overall program-wide assessment criteria specified above, this ranks as good. These results support the conclusion that LA results in air and dust samples are reproducible and that TEM analytical precision is not likely to be impacted by filter preparation methods.

[15] The minimum repreparation frequency requirements specified in LB-000029B first became effective in 2003.

Section 9
PCM Laboratory Quality Control Evaluation

At the Libby site, PCM has primarily been used to analyze personal air samples for workers collected as part of health and safety requirements. More than 18,400 air samples have been collected and analyzed by PCM. Nearly all PCM analyses (>90%) are performed at the Mobile Lab in Libby which allows for a rapid turnaround time in result reporting and ensures any potential health and safety issues are quickly identified and addressed.

Laboratory-based QC samples for PCM are based on the requirements specified by AIHA. This includes daily checks of microscope resolution, daily analysis of one or more reference slides (slides analyzed repeatedly over time to determine the precision of each analyst), and re-analysis of at least 10% (a minimum of one per day) of all field samples.

PCM QC analysis results are not included in the LIMS-derived PCM EDD that is uploaded to the Libby2 database. Therefore, it is not possible to prepare tabular and graphical summaries of PCM QC results from the project database. However, the Mobile Lab includes a summary of any PCM QC results as part of the monthly analysis reports provided to the Libby laboratory contractor (CDM Smith). PCM QC results for the Mobile Lab have met the requirements specified ISO/IEC 17025:2005 *General Requirements for the Competence of Testing and Calibration Laboratories*. Thus, it is concluded that inadvertent contamination of air samples due to PCM laboratory practices is not of significant concern and that PCM results are reproducible and reliable.

Section 10
PLM Laboratory Quality Control Evaluation

PLM analysis QC samples are used to ensure that analytical laboratory practices do not introduce potential contamination and to evaluate analysis precision. At the Libby site, soil samples are analyzed by PLM using both the NIOSH 9002 and the PLM-VE methods. As noted previously in Section 4.1.3, historically, all soil samples at the Libby site were analyzed using NIOSH 9002. Beginning in early 2003, most investigative soil samples at the Libby site have been analyzed using PLM-VE following soil preparation at the CSF, while non-investigative samples (i.e., soil samples collected in support of cleanup design and confirmation sampling) are analyzed by NIOSH 9002 at the Mobile Lab in Libby.

10.1 PLM NIOSH 9002

Results for laboratory QC samples analyzed by PLM NIOSH 9002 are not routinely included in the LIMS-derived EDD that is uploaded to the Libby2 database. Therefore, it is not possible to prepare comprehensive tabular and graphical summaries of these results from the project database. Hard copy laboratory data reports have regularly been checked by the Libby laboratory contractor (CDM Smith) and very few discrepancies have been observed. QC results for all PLM NIOSH 9002 laboratories have met the requirements specified by NIST/NVLAP, as prescribed in *NIST Handbook 150-3, NVLAP Bulk Asbestos Analysis* (NIST 2006). Thus, it is concluded that inadvertent contamination of soil samples due to laboratory practices is not of significant concern and that PLM NIOSH 9002 results are reproducible and reliable.

10.2 PLM-VE

Three types of laboratory-based QC analyses are performed for PLM-VE, including laboratory duplicates, interlab analyses, and PE standards. Each of type of QC sample is discussed in more detail in the following sections.

10.2.1 Laboratory Duplicates

Historically, a laboratory duplicate was a repreparation of a soil sample slide by a different analyst within the same laboratory than who performed the initial analysis. Beginning in the fall of 2008 (see Revision 2 of SOP SRC-LIBBY-03), a "self-check" laboratory duplicate was added to the PLM-VE QC program. A self-check laboratory duplicate is a repreparation of a soil sample evaluate by the same analyst (laboratory duplicates analyzed by a different analyst are referred to as a "cross-check" analysis). The target frequency for laboratory duplicates is 1 per 10 analyses (10%).

A total of 3,092 laboratory duplicates have been analyzed by PLM-VE between 2002 and 2009. **Table 10-1** presents the frequency of laboratory duplicate analyses for each PLM-VE laboratory. As shown, the program-wide laboratory duplicate frequency from 2002 to 2009 was about 11%. With few exceptions, laboratory duplicate analysis

frequencies for each laboratory have usually met or exceeded the frequency requirements specified in SOP SRC-LIBBY-03.

Table 10-2 presents a comparison of the original sample results to the laboratory duplicate results for cross-check (Panel A) and self-check (Panel B) analyses. Results are ranked as concordant if both the original sample result and the laboratory duplicate result report the same semi-quantitative classification (concordant pairs are shaded in gray). Results are ranked as weakly discordant if the original sample result and the laboratory duplicate result differed by one semi-quantitative classification bin (i.e., Bin A vs. Bin B1). Results are ranked as strongly discordant if the original sample result and the laboratory duplicate result differed by more than one semi-quantitative classification bin (i.e., Bin A vs. Bin B2). As specified in SOP SRC-LIBBY-03, laboratory duplicate results are deemed "acceptable" if results are within one bin (i.e., are not strongly discordant).

As seen, overall concordance was very good for both cross-check and self-check laboratory duplicates (>96%). When results were different between the original sample and the laboratory duplicate, they were usually only weakly discordant. There were only four instances (about 0.1% of all laboratory duplicates) where the original sample result and the laboratory duplicate result were strongly discordant. An evaluation of the four pairs that were strongly discordant did not indicate that differences were due to any one laboratory or one analyst in particular. These results support the conclusion that the soil sample results for PLM-VE are reproducible and reliable and are not greatly influenced by differences in laboratory analysis techniques between analysts at the same laboratory.

10.2.2 Interlab Analyses

An interlab is a re-analysis of an aliquot of the original soil sample by an analyst from a different laboratory than who performed the initial analysis. Interlab analyses provide information on potential differences in analytical techniques between laboratories. Results for interlab analyses are evaluated using the same concordance ranking method described above. As specified in LB-000073, the minimum frequency for the analysis of interlabs is 1% and the overall program-wide assessment criteria for interlabs are as follows:

Metric	Program-Wide Assessment		
	Good	Acceptable	Poor
% of interlab pairs ranked as strongly discordant	<5%	5-10%	>10%

Because there have been several interlab studies conducted, and the interlab selection procedure has changed over time, results are discussed chronologically.

2002-2004 Interlabs

Early in the Libby sampling program (2002-2004) as part of the development of the Libby-specific PLM-VE SOP, soil samples were selected randomly for interlab

analysis by PLM-VE. **Table 10-3** presents a comparison of the original sample results to the interlab results for PLM-VE. As shown, concordance rates were generally good (94%). However, because nearly all of the samples evaluated were non-detect, these results provide little information on potential differences between laboratories for soils with detectable levels of LA.

2004 CSS Interlab Pilot Study

In May of 2004, EPA performed a pilot study to assess potential differences in analytical techniques between the Libby laboratories performing PLM-VE analyses. Five laboratories were evaluated in the pilot study, including Batta Environmental Associates, Hygeia Laboratories, RESI, MAS, and EMSL Analytical (Westmont, NJ). A total of 60 soil samples from the CSS were submitted to the inter-laboratories. These samples were selected based on the original PLM-VE results to represent each semi-quantitative classification bin (i.e., 17 Bin A samples, 19 Bin B1 samples, 19 Bin B2 samples, 5 Bin C samples). The same fine, ground aliquot that was originally analyzed was sent to the inter-laboratory for analysis by PLM-VE. These samples were not submitted blind (i.e., the inter-laboratory knew the sample was an interlab), but the inter-laboratory did not know the results of the original analysis.

Table 10-4 presents a comparison of the original sample results to the interlab results for the 2004 CSS pilot study. As seen, concordance rates were low (43%). But, when results were different between the original sample and the interlab, they were often only weakly discordant (i.e., within one bin). In general, when results were discordant, the original PLM-VE results tended to be higher than the interlab results. There were five instances (8.3%) where the original sample result and the interlab result were strongly discordant. An evaluation of the five pairs that were strongly discordant did not indicate that differences were due to any one laboratory in particular.

Because the inter-laboratory concordance rates (43%) were much lower than those for the intra-laboratory duplicates (>95%), these results suggested that there may have been differences in analytical techniques between the analytical laboratories performing PLM-VE analyses. The observation that the original analysis results were often higher than the interlab results supported the theory that these weak discordances may have been due to the fact that the concentration in the soil aliquot examined by the inter-laboratory was altered as a consequence of the original analysis.

Post-hoc Selection Interlabs

Beginning in April 2008, the procedure for selecting samples for interlab analysis was revised so that the sample selection was *post-hoc* (i.e., based on a consideration of the results the original PLM-VE analysis). This *post-hoc* selection procedure allowed for the preferential selection of samples that were representative of each PLM-VE classification bin (e.g., Bin A, Bin B1, etc.). In addition, the interlab analysis was performed on a second fine, ground aliquot from the same soil sample. This second fine, ground aliquot was added to the sample train by the CSF, thus making the

interlab sample blind to the inter-laboratory (i.e., it cannot distinguish the interlab sample from other field samples on the field COC form)[16].

Table 10-5 presents a comparison of the original sample results to the interlab results for the *post hoc* selection samples. As seen, results are similar to the 2004 CSS interlab pilot study, with low concordance rates (54%), discordances tending to be within one bin (i.e., weakly discordant), and the original results tending to be higher than the interlab results. Because interlab samples were performed on a different fine, ground aliquot than was analyzed in the original analysis, the fact that the interlab results tended to be lower than the original analysis cannot be attributed to an alteration of the soil aliquot by the initial analysis. These results supported the conclusion that there were differences in visual area estimation techniques between the analytical laboratories performing PLM-VE analyses.

July 2008 Johnston Conference

The Libby laboratory team has convened on multiple occasions at the ASTM Johnston Conference in Burlington, Vermont to discuss analytical topics related to the Libby site. At the June 2008 conference, EPA presented findings from PLM-VE interlab evaluations performed for the Troy site. At the Troy site, all PLM-VE analyses for soil samples are performed by the ESAT laboratory, with interlab analyses performed at RESI and EMSL. In brief, the interlab evaluation suggested that there was a potential bias, with results from ESAT tending to be higher than the inter-laboratories. Following a face-to-face meeting between senior analysts from each laboratory, it was determined that there were indeed differences in PLM-VE analytical techniques between the laboratories. The Libby-specific SOP for PLM-VE (SOP SRC-LIBBY-03) was subsequently revised to incorporate changes to better standardize visual area estimation methods for LA.

2008 ESAT/RESI Interlab Study, Round 1

Following the 2008 Johnston Conference, ESAT performed several PLM-VE interlab analyses for soil samples from the Libby site originally analyzed by RESI. **Table 10-6** presents a comparison of the original RESI sample results to the ESAT interlab results. As shown, concordance rates were low (51%). When results were different between the original sample and the interlab, they were always weakly discordant (i.e., no results were ranked as strongly discordant). However, when results were discordant, there was a clear tendency for PLM-VE results from ESAT to be higher than results from RESI (i.e., more than half of samples reported as Bin A by RESI were reported as Bin B1 by ESAT). These results suggested that there were differences in visual area estimation methods between ESAT and RESI analysts.

[16] One consequence of the fact that these interlab samples are blind to the analytical laboratory is that, when results are reported, they are not identified as "interlabs" in the EDD (or in the Libby2 database). See **Appendix B** for details on how blind PLM interlabs were identified in the database.

December 2008 Round Robin Study

In order to provide information on the reproducibility of PLM-VE results from RESI, in December of 2008, a small round robin study was performed to evaluate potential differences in PLM-VE methods between four of the Libby laboratories. In this study, eight soil samples originally analyzed by RESI in November 2008 were selected for interlab analysis. Three PLM-VE laboratories (Hygeia Laboratories, Mobile Lab, and MAS) each received a distinct fine, ground aliquot from each selected soil samples. These fine, ground aliquots were added to the sample train by the CSF, thus making the interlab sample blind to the inter-laboratory (i.e., it cannot distinguish the interlab sample from other field samples on the field chain of custody form).

Table 10-7 summarizes the results for each soil sample by laboratory. As shown, with few exceptions, the inter-laboratories were consistent in the PLM-VE bin classification. There were only two samples where the PLM-VE results differed across laboratory. These results support the conclusion that PLM-VE results from RESI were consistent with reported results by the other three Libby laboratories.

2009 ESAT/RESI Interlab Study, Round 2

In October 2009, RESI performed several PLM-VE interlab analyses for soil samples from the Libby site originally analyzed by ESAT. **Table 10-8** presents a comparison of the original ESAT sample results to the RESI interlab results. As shown, concordance rates continue to be low (54%) and PLM-VE results reported by ESAT continue to be higher than results reported by RESI. These results demonstrate that there continue to be differences in visual area estimation methods between ESAT and RESI analysts.

Conclusions

The low concordance rates for interlabs relative to laboratory duplicates show that there are differences in visual area estimation methods between the PLM-VE laboratories. However, when results differed between laboratories, they were often only weakly discordant (i.e., within one bin), which is within the expected analytical measurement error associated with the PLM-VE method.

10.2.3 PE Standards

PE standards are samples with known levels of asbestos contamination which evaluate analytical accuracy. Libby-specific PE standards for soil have been created for use at the Libby site. These PE standards were created by spiking soil with known quantities of LA obtained from the mine located on Vermiculite Mountain near Libby. Aliquots of these PE standards are randomly added to the soil sample batches at the time of sample preparation in the CSF (i.e., they are blind to the analytical laboratories).

Results for PE standards are evaluated for concordance using a procedure similar to that described above for laboratory duplicates and interlabs. Results are ranked as concordant if the PLM-VE result for the PE standard reports the correct semi-quantitative classification (as assigned based on the nominal level). In order to avoid "unblinding" the nominal levels in the PE standards to the analytical laboratories, detailed results tables are not presented in this report, but a description of the results is discussed below.

A total of 17 PE standards have been submitted for PLM-VE analysis through December 2009. Notably, RESI is the only laboratory that has consistently analyzed PE standards as part of ongoing PLM-VE analyses of soil. In the fall/winter of 2008, ESAT analyzed two PE standards and Batta analyzed one PE standard. No other PLM-VE laboratories have analyzed PE standards.

For RESI, concordance rates for PE standards were about 65%. When results were discordant, they were usually only weakly discordant (i.e., within one bin) and tended to be biased high. PE standards with nominal LA levels near bin boundaries were the most difficult to assign accurately. These results are consistent with PE standard concordance rates for PLM-VE presented in the *Performance Evaluation of Laboratory Methods for the Analysis of Asbestos in Soil* (EPA 2008b) and support the conclusion that PLM-VE results have a high degree of uncertainty.

For ESAT and Batta, PLM-VE results for PE standards were always ranked as weakly discordant and consistently biased high. However, too few samples have been analyzed to draw any firm conclusions on PLM-VE result accuracy.

Section 11
Summary and Recommendations

11.1 QA/QC Summary

Investigations at the Libby site have generated a large amount of data on the concentration of LA in samples of air, dust, soil, and other media. EPA has invested substantial effort in the QA/QC program for the Libby site to ensure that these data are of good quality and are sufficient to support risk management decisions about the nature and extent of contamination and the need for cleanup.

Key elements of the QA plan included:

- The development of detailed SAPs and QAPPs to guide all sample collection and analysis efforts.
- The development of detailed site-specific SOPs for sample collection, preparation, and analysis.
- Extensive training of all field and laboratory staff.
- Extensive review and checking by senior staff of the work performed by field and laboratory staff.
- Periodic internal and external audits of field and laboratory operations.
- Iterative modifications to improve methods and document procedures used to address any issues or problems identified by field staff, laboratory staff, or data users.
- The development of electronic data management tools for recording and transferring data that include a variety of error checks and error traps.
- The collection and analysis of a variety of different types of QC samples.
- A review and verification of electronic data in the Libby2 database.

Based on the QC data that have been collected at the Libby site, it is concluded that:

- Blank samples (e.g., lot blanks, field blanks, preparation blanks, laboratory blanks) show that inadvertent contamination of field samples with LA or other forms of asbestos is not of significant concern, in the field, at the CSF, or at the analytical laboratory.
- Field duplicate and split samples for air, dust, and soil show that variability due to small-scale heterogeneity is likely to be small and results tend to be reproducible.

- Soil preparation duplicates show that results are not greatly influenced by differences in CSF preparation techniques.

- For both TEM and PLM, there is generally high agreement (good concordance) for intra-laboratory analyses. Inter-laboratory analyses suggest that, while results are generally acceptable, there are differences in methods or procedures between analytical laboratories and corrective action may be useful in achieving better agreement and reducing uncertainties due to analytical measurement errors.

11.2 Recommendations

While this report has demonstrated that QA/QC procedures have been effective in ensuring that the data collected at the Libby site are of high quality, there are several modifications that can be made that will assure continued high quality in the future. These recommendations are summarized below:

- Although several data verification efforts have been performed in support of specific investigations, it would be beneficial to perform an ongoing verification for a subset of all data uploaded to the Libby2 database (e.g., 10% of all samples uploaded each month) to ensure high data quality for both investigative and non-investigative samples and to quickly identify/rectify potential issues.

- Prior to 2009, the Libby laboratories participated in regular teleconferences with EPA and their contractors to discuss any technical or procedural issues and analytic requirements for ongoing investigations. It is recommended that regular (e.g., monthly) teleconferences resume.

- While investigation-specific data summary reports have often summarized results for associated QC samples, an ongoing, real-time evaluation of QC data and reporting of results has not been done. To ensure that any potential issues are quickly identified and rectified, it is recommended that QC data be evaluated on a quarterly basis and results summarized in an addendum to this report.

- Although PCM NIOSH 7400 and PLM NIOSH 9002 laboratory QC analyses are routinely performed, results for these analyses are not captured in the Libby2 database because they are not routinely included on the LIMS-based EDDs. To ensure that data quality is transparent to all data users, it is recommended that laboratory QC analyses be included as part of the PCM NIOSH 7400 and PLM NIOSH 9002 EDDs. At a minimum, the monthly reports (that summarize these laboratory QC results) from the respective laboratories should be made available to Libby project data users (e.g., *via* posting to the Libby eRoom or some other accessible electronic repository).

- Inter-laboratory evaluations of TEM and PLM-VE suggest that there are differences in methods and procedures between analytical laboratories. Interlab analyses should continue to be performed on a regular basis by all analytical laboratories. When differences are noted, to the extent feasible, corrective actions should require

a meeting (e.g., face-to-face, web-based) between any associated analysts to identify and rectify differences in analysis methods.

- Currently, PE standards for soil are inserted into the sample train at the time of preparation. Because they are inserted randomly, the frequency of analysis is quite variable across PLM-VE analytical laboratories. Because the interlab results have demonstrated that there are method differences between the PLM-VE laboratories, it is recommended that the PE standards be inserted at a specified laboratory-specific frequency (e.g., 2%) to allow for an evaluation of accuracy and potential bias for each laboratory.

- This report includes several recommendations for adding data quality flags (e.g., FB, EB, PB) to some field samples in the database to alert data users to potential issues related to blank contamination. The Libby2 database should be modified to incorporate the recommended data qualifiers.

- There have been several data verification evaluations of the Libby2 database (see **Table 5-1**). Detailed results of these data verification efforts have been provided in several investigation-specific verification summary reports. While many of the errors identified in these reports have been corrected in the Libby2 database, not all changes have been made. The Libby2 database should be updated as appropriate to correct any errors identified as part of the data verification efforts.

- To ensure transparency to all data users, it is recommended that hard copies of all field and laboratory documentation (e.g., FSDS forms, field logbooks, PSDS forms, lab job reports) be made available to Libby project data users (e.g., *via* posting of PDF documents to the Libby eRoom or some other accessible electronic repository).

- If laboratories do not receive samples for extended periods of time, it is recommended that the analyst receive re-training on proper data recording procedures at the bench and for the data entry person to ensure complete and accurate data report packages.

Section 12
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Appendices

All appendices will be provided electronically on compact disc or as a set of downloadable files.

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Figures

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Figure 2-1. Example Chain of Custody Form

Chain of Custody Record

Libby Asbestos Investigation

No. L6986

From: CDM
318 Louisiana Ave
Libby, MT 59923

U.S. Environmental Protection Agency, Region VIII
999 18th Street, Suite 300
Denver, CO 80202-2413

Send to: CDM Soil Lab
2714 Walnut St
Denver, CO 80202

via: ☐ hand delivery ☑ shipped

Date Shipped: 10/14/2003
Carrier Name: Fed-Ex
Airbill: 8433 9388 0032

Sample Placed in Cooler/Bag	Index ID	Suffix ID	Sample Date	Sample Media (S=Soil; W=Water; D=Dust; A=Air;B=Bulk Insulation)	Volume (L) or Area (cm2)	Filter Pore Size (um)	Turn Around Time	Analysis Request	Comments	Sample Received by Lab
☐	CS-17541	B	10/13/2003	S	NA	NA	3 Day	Soil Prep (ISSI-LIBBY-01 (Rev 7))		☐
☐	CS-17542	B	10/13/2003	S	NA	NA	3 Day	Soil Prep (ISSI-LIBBY-01 (Rev 7))		☐
☐	CS-17543	B	10/13/2003	S	NA	NA	3 Day	Soil Prep (ISSI-LIBBY-01 (Rev 7))		☐
☐	CS-17574	B	10/10/2003	S	NA	NA	3 Day	Soil Prep (ISSI-LIBBY-01 (Rev 7))		☐
☐	CS-17575	B	10/10/2003	S	NA	NA	3 Day	Soil Prep (ISSI-LIBBY-01 (Rev 7))		☐
☐	CS-17576	B	10/10/2003	S	NA	NA	3 Day	Soil Prep (ISSI-LIBBY-01 (Rev 7))		☐
☐	CS-17577	B	10/10/2003	S	NA	NA	3 Day	Soil Prep (ISSI-LIBBY-01 (Rev 7))		☐
☐	CS-17578	B	10/10/2003	S	NA	NA	3 Day	Soil Prep (ISSI-LIBBY-01 (Rev 7))		☐
☐	CS-17579	B	10/13/2003	S	NA	NA	3 Day	Soil Prep (ISSI-LIBBY-01 (Rev 7))		☐
☐	CS-17580	B	10/13/2003	S	NA	NA	3 Day	Soil Prep (ISSI-LIBBY-01 (Rev 7))		☐

Total Number of Samples 10

END OF SUBMITTAL

Additional Comments:

Peter King CDM 10-14-03 1100

Relinquished by (Signature and Company)	Date/Time	Received by (Signature and Company)	Date/Time	Sample Condition upon Receipt
Relinquished by (Signature and Company)	Date/Time	Received by (Signature and Company)	Date/Time	Sample Condition upon Receipt
Relinquished by (Signature and Company)	Date/Time	Received by (Signature and Company)	Date/Time	Sample Condition upon Receipt

S Sample Coordinator Copy

Figure 2-2. LFO Modification Form Template

Record of Modification

to the

Libby Sampling and Quality Assurance Project Plan

Field Activities

LFO-0000__

Instructions to Requester: **Fax to contacts at bottom of form for review and approval.**
File approved copy with Data Manager at the Libby Field Office (LFO).
Data Manager will maintain legible copies in a binder that can be accessed by LFO personnel.

Project QAPP (circle one): Phase I (approved 4/00) Phase II (approved 2/01)
Removal Action (approved 7/00) Contaminant Screening Study (approved 5/02)
Other (Title and approval date):_____

SOP (Number and Revision No.):_____
_____
_____

Other Document (Title, Number/Revision): _____

Requester: _____ Title: _____
Company: _____ Date: _____

Description of Modification (attach additional sheets if necessary; state section and page numbers of SQAPP when applicable):_____
_____
_____
_____

Field logbook and page number Modification is documented on: _____

Reason for Modification: _____
_____
_____
_____

Duration of Modification (circle one):
Temporary Date(s):_____
Resident address(es): _____
_____

- If appropriate, attach a list of all applicable Index Identification numbers.

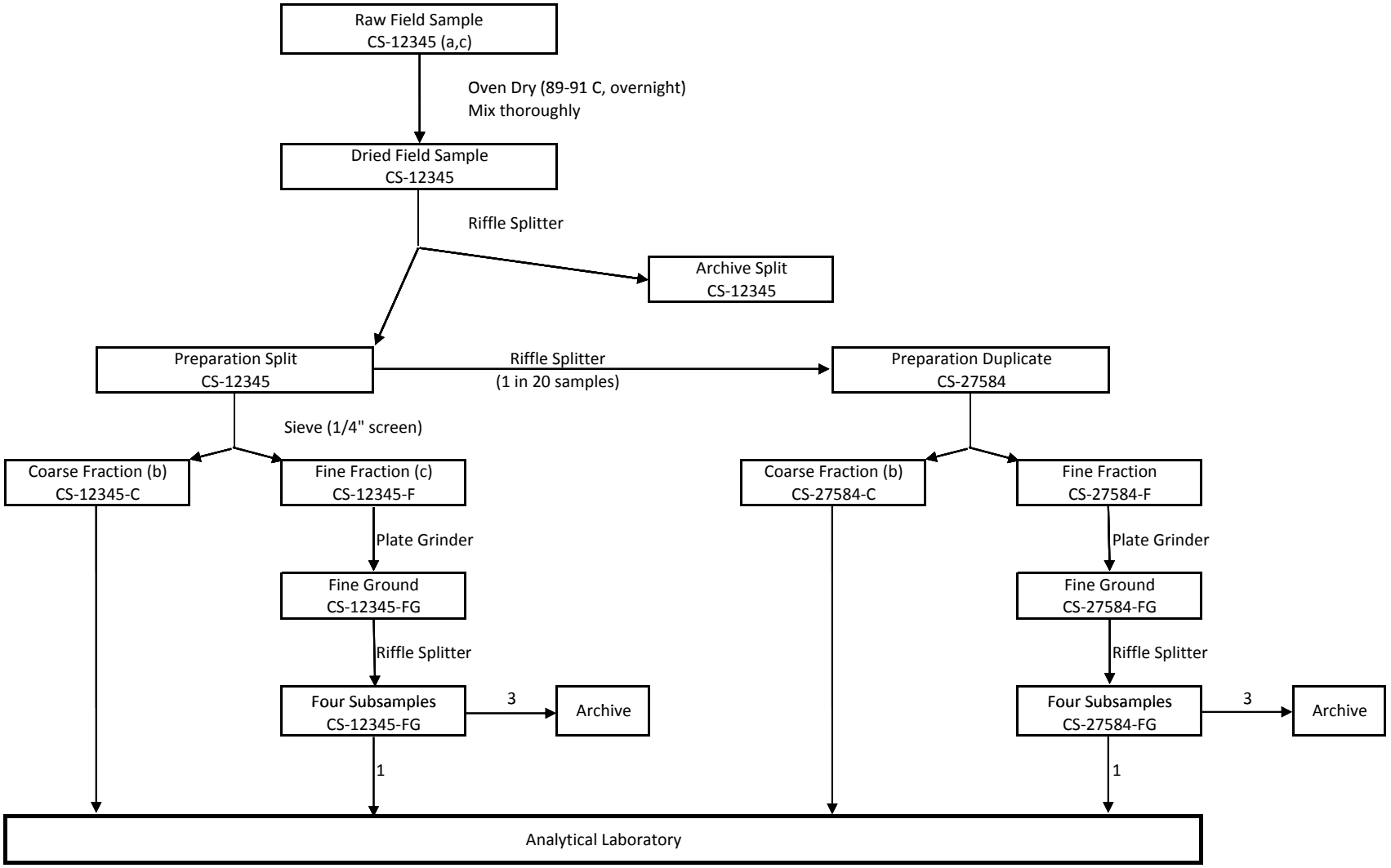
Permanent (complete Proposed Modification Section) Effective Date:_____

Potential Implications of Modification:_____
_____
_____
_____

Technical Review and Approval: _____ Date:_____
(Volpe Project Manager or designate)

EPA Review and Approval: _____ Date:_____
(USEPA RPM or designate)

FIGURE 3-1. SOIL PREPARATION FLOW DIAGRAM



(a) Example sample number shown to illustrate naming conventions
(b) Coarse sample will be returned to EPA for archive after laboratory analysis
(c) Preparation blanks (clean quartz sand) will be processed with each batch and subject to drying followed by fine fraction grinding. Intermediate steps do not apply

Figure 3-2. Example CSF Modification Form

MOD No.: CSF-_____

Request for Modification
To
Soil Sample Preparation Activities

Instructions to Requester: E-mail form to contacts at bottom of form for review and approval.

File approved copy at the Close Support Facility (CSF). CSF personnel distributes approved forms as follows:

EPA, Volpe, Laboratory Coordinator (CDM)

Method (circle one/those applicable): ISSI-LIBBY-01 (Rev. 7), Other:_____

Requester:_____ Title: _____

Company: _____ Date: _____

Effective Date: _____

Description of Modification:

_____

_____

Reason for Modification:

_____

_____

Potential Implications of this Modification:

_____

_____

Duration of Modification (circle one):

Temporary Date(s): _____

Preparation Batch ID:_____

- Temporary Modification Forms – Attach legible copies of approved form with all associated chain-of-custody forms. Also, maintain legible copies of approved form in a binder that can be accessed by CSF personnel.

Permanent (complete Proposed Modification Section)

Permanent Modification Forms –

- Permanent Mod applies to (circle one):

C B F FG AC AB AF AFG N/A

- Maintain legible copies of approved form in a binder that can be accessed by CSF personnel.

Data Quality Indicator –

- Please reference XXX for direction on selecting data quality indicators:

Reject Low Bias Estimate High Bias No Bias

Proposed Modification to Method (attach additional sheets if necessary; state section and page numbers of Method when applicable):

_____

_____

Technical Review: _____ Date: _____

(CDM Close Support Facility Manager or designate)

Approved By:_____ Title: _____ Date: _____

*(*USDOT Volpe Center: Mark Raney*)*

Approved By:_____ Title: _____ Date: _____

(USEPA: Project Chemist or designate)

Figure 4-1. Laboratory Modification Form Template

Request for Modification
to
Laboratory Activities
LB-_____

Instructions to Requester: E-mail form to contacts at bottom of form for review and approval.
File approved copy with Data Manager (CDM). Data Manager distributes approved forms as follows:
All Labs Applicable forms – copies to: EPA, Volpe, CDM, All project labs
Individual Labs Applicable forms – copies to: EPA, Volpe, CDM, Initiating Lab

Method (circle one/those applicable): TEM-AHERA TEM-ISO 10312 PCM-NIOSH 7400 NIOSH 9002
EPA/600/R-93/116 ASTM D5755 EPA/540/2-90/005a SRC-LIBBY-03
Other:_____

Requester:_____ Title: _____
Company: _____ Date: _____

Description of Modification:

_____

_____

Reason for Modification:

_____

_____

Potential Implications of this Modification:

_____

_____

Laboratory Applicability (circle one): All Individual(s) _____

_____

Duration of Modification (circle one):
Temporary Date(s): _____
Analytical Batch ID: _____
Temporary Modification Forms – Attach legible copies of approved form w/ all associated raw data packages

Permanent (Complete Proposed Modification Section) Effective Date: _____
Permanent Modification Forms – Maintain legible copies of approved form in a binder that can be accessed by analysts.

Data Quality Indicator (circle one) – Please reference definitions on reverse side for direction on selecting data quality indicators:

Not Applicable **Reject** **Low Bias** **Estimate** **High Bias** **No Bias**

Proposed Modification to Method (attach additional sheets if necessary; state section and page numbers of Method when applicable):

_____

_____

Technical Review: _____ Date: _____
(Laboratory Manager or designate)

Project Review and Approval: _____ Date:_____
(Volpe: Project Technical Lead or designate)

Approved By:_____ Date: _____
(USEPA: Project Chemist or designate)

DATA QUALITY INDICATOR DEFINITIONS

Reject - Samples associated with this modification form are not useable. The conditions outlined in the modification form adversely effect the associated sample to such a degree that the data are not reliable.

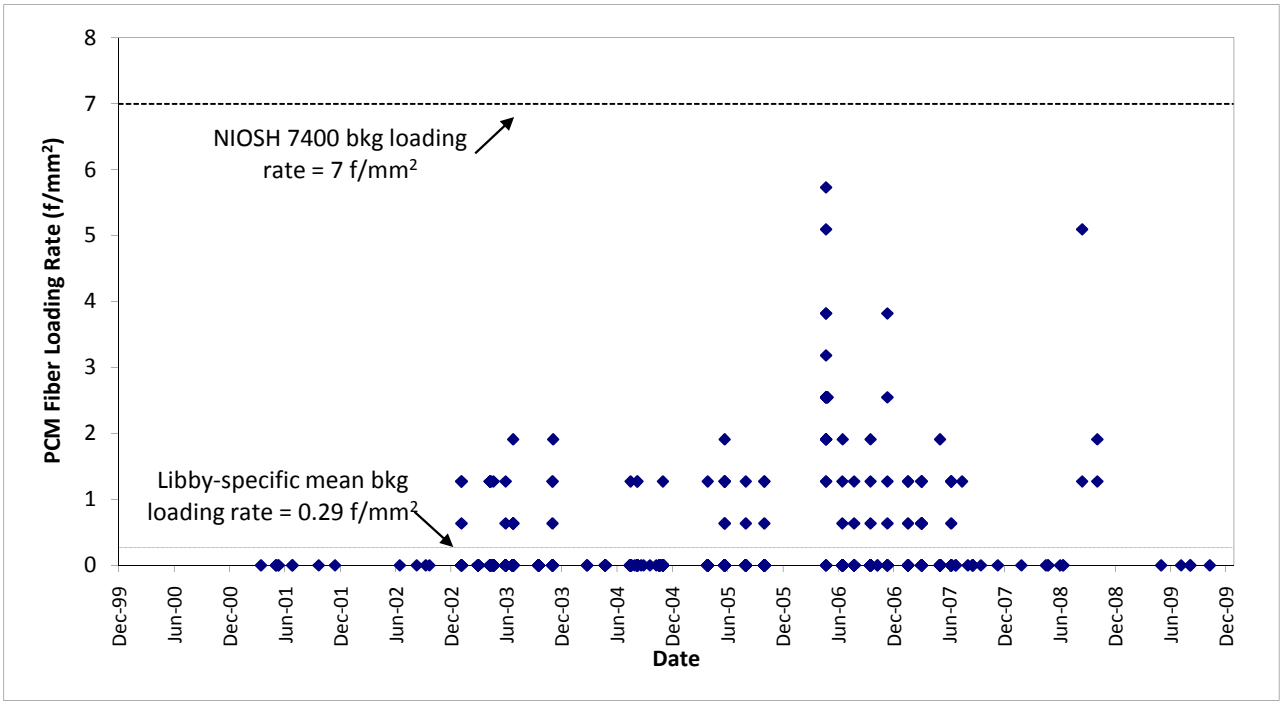
Low Bias - Samples associated with this modification form are useable, but results are likely to be biased low. The conditions outlined in the modification form suggest that associated sample data are reliable, but estimated low.

Estimate - Samples associated with this modification form are useable, but results should be considered approximations. The conditions outlined in the modification form suggest that associated sample data are reliable, but estimates.

High Bias - Samples associated with this modification form are useable, but results are likely to be biased high. The conditions outlined in the modification form suggest that associated sample data are reliable, but estimated high.

No Bias - Samples associated with this modification form are useable as reported. The conditions outlined in the modification form suggest that associated sample data are reliable as reported.

FIGURE 6-1. PCM FIBER LOADING RATES FOR LOT BLANKS

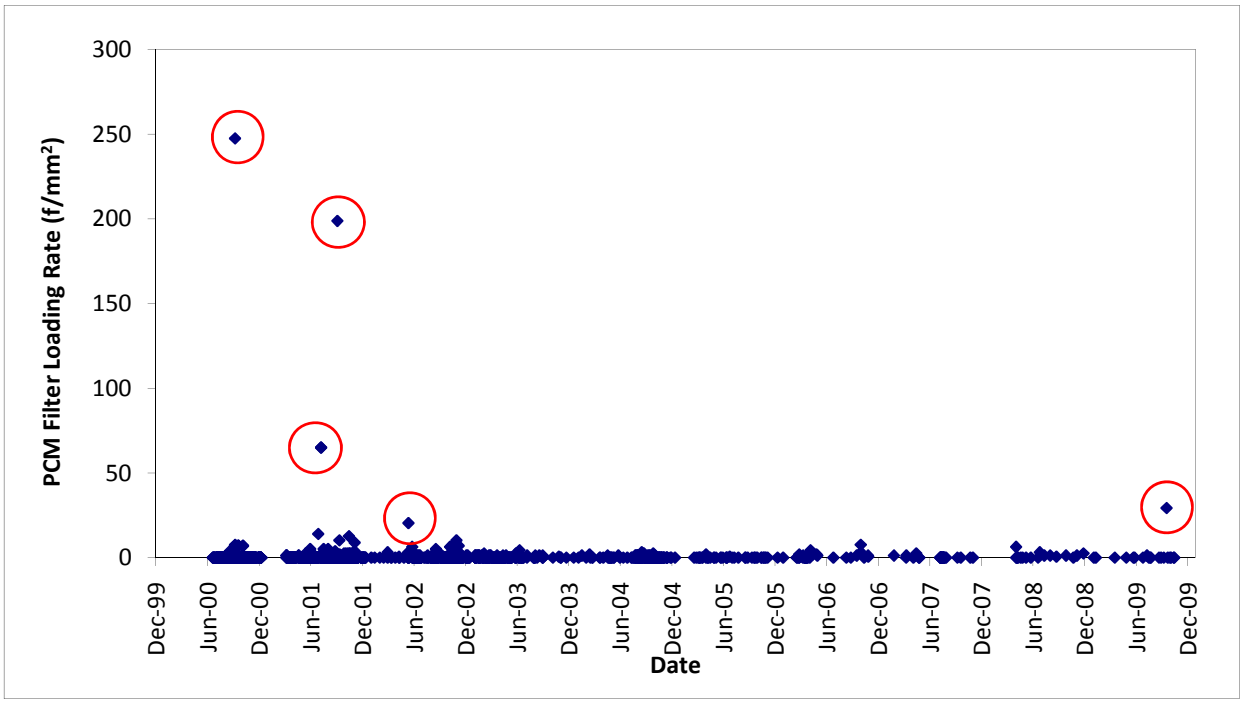


Libby2DB Download: 12/8/2009

bkg = background
f/mm^2 = fibers per square millimeter
NIOSH = National Institute for Occupational Safety and Health
PCM = phase contrast microscopy

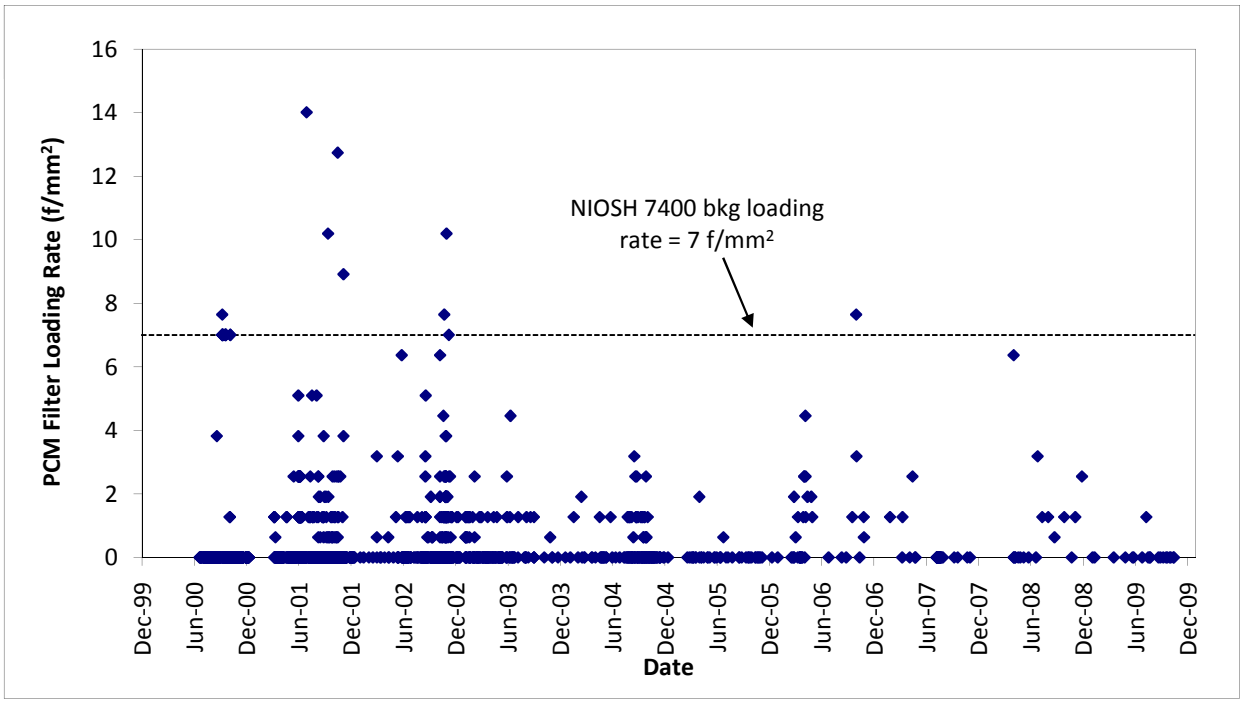
FIGURE 6-2. PCM FILTER LOADING IN AIR FIELD BLANKS

Panel A: PCM Field Blank Loading Rate (with 5 suspect samples)



Circled values are field blanks that are suspected to actually be field samples.

Panel B: PCM Field Blank Loading Rate (5 suspect samples excluded)

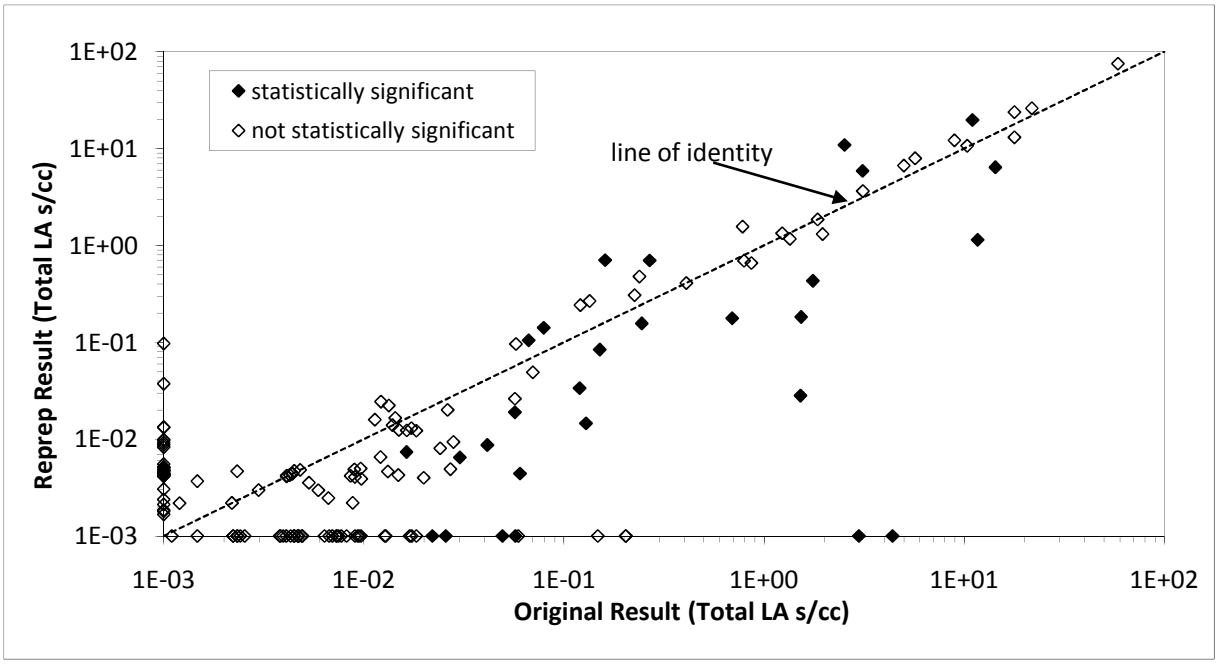


Libby2DB Download: 12/8/09

bkg = background
f/mm^2 = fibers per square millimeter
NIOSH = National Institute for Occupational Safety and Health
PCM = phase contrast microscopy

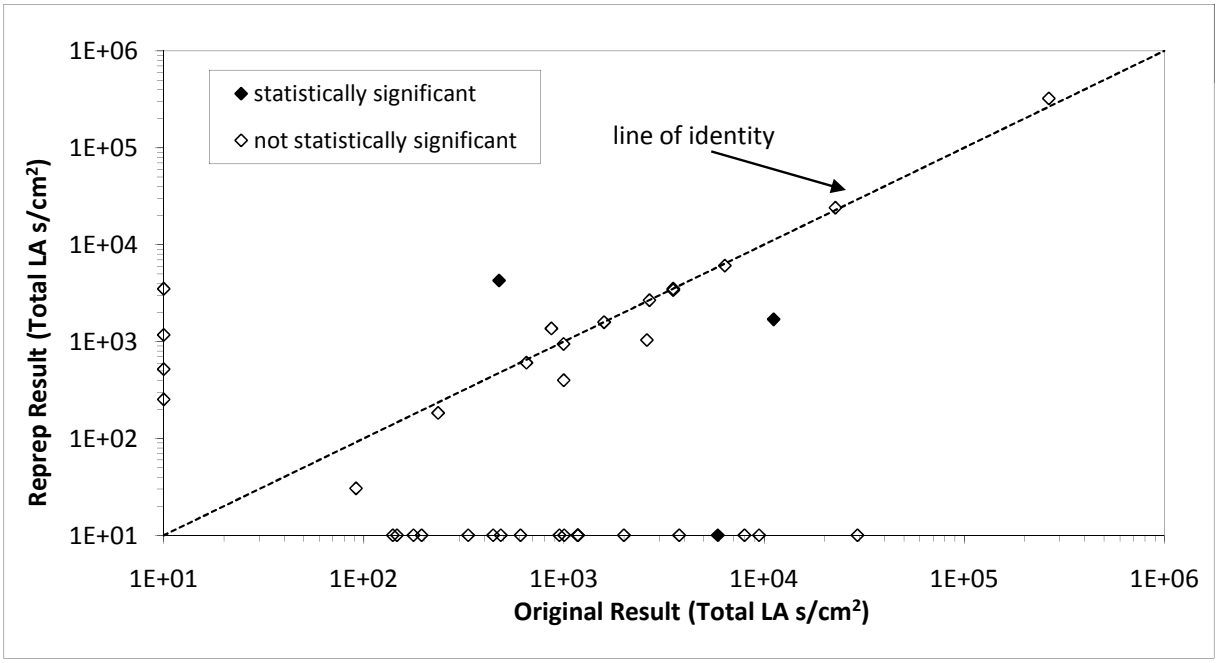
FIGURE 8-1. TEM REPREPARATION RESULTS

Panel A: Air



Non-detects for air are plotted at 1.00E-03 s/cc in the above figure.

Panel B: Dust



Non-detects for dust are plotted at 1.00E+01 s/cm^2 in the above figure.
Libby2DB Download: 12/8/09

LA = Libby amphibole
s/cc = structures per cubic centimeter
s/cm^2 = structures per square centimeter
TEM = transmission electron microscopy

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Tables

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TABLE 1-1. SUMMARY OF DATA COLLECTION PROGRAMS AT THE LIBBY SUPERFUND SITE

Program	Time Period	Purpose
Phase 1	12/1999 - 10/2006	Obtain initial data on LA levels in air, soil, vermiculite, and mine wastes.
Phase 1R	3/2000 - 7/2009	Obtain data needed to plan and evaluate outdoor and indoor cleanup activities
Phase 1A	8/2001 - 9/2002	Obtain outdoor stationary air data from the County Annex Building.
Phase 2 Residential Activity-Based Sampling (ABS)	3/2001 - 11/2001	1) Evaluate PCM vs TEM, stationary vs personal. 2) Obtain preliminary ABS data needed to develop risk assessment strategy.
Contaminant Screening Study (CSS)	2002 - 7/2009	1) Collect information about the presence of potential LA source materials at individual residential and commercial properties. 2) Classify each property as (a) requiring immediate emergency response cleanup, (b) potentially impacted, but needing additional information to determine if cleanup is necessary, and (c) likely not impacted or requiring cleanup.
Design Phase	4/2003 - 11/2009	Collect detailed data needed to plan cleanup actions at each property
Supplemental Quality Assurance Project Plan for the Remedial Investigation (SQAPP)	6/2005 - 10/2006	Obtain data for combination with existing information in support the completion of a comprehensive RI Report and the first Record of Decision (ROD) for the Libby Asbestos Site.
Clean-up Evaluation	11/2003 - 2/2004	1) Determine the magnitude of the reduction in exposure level due to the clean-up. 2) Determine the residual exposure levels of residents in homes after clean-ups have been completed. 3) Determine if residual sources such as dust inside air ducts and furnaces or in carpets and upholstery cause re-contamination of indoor dust in a home, and if so, is that of concern.
Cumulative Risk Study	11/2005 - 12/2005	Intended to provide information concerning: 1) the sampling issues and problems associated with performing cumulative exposure assessments on individuals, and 2) the cumulative exposures that are experienced by EPA staff and/or contractors that are moving around town, but not directly involved in vermiculite or asbestos clean-up activities.
Demolition Monitoring	6/2005 and 10/2006	1) Obtain data to determine if a release of asbestos occurred as a result of building demolition activities. 2) If so, determine if the release caused environmental contamination that is large enough to warrant removal action under the December 2003 Action Plan.
Ambient Air Monitoring	10/2006 - 6/2008	1) Obtain data to characterize the long-term average concentrations of LA. 2) Characterize spatial patterns and temporal trends of LA in outdoor ambient air within the study area.
OU4 Residential ABS	5/2007 - 6/2008	Evaluate the efficacy and protectiveness of the cleanup strategy taken in OU4 at the Libby Asbestos Site by investigating residual levels of exposure and risk from indoor and outdoor ABS scenarios.
OU5 Worker and Recreational Visitor ABS	10/2007 - 1/2008 (Indoor) 7/2008 - 10/2008 (Outdoor)	Obtain data to characterize current indoor and outdoor levels of LA in OU5 air and soil for indoor workers, outdoor workers, recreational visitors, and motocross riders.
Public Schools Monitoring	12/2008 (Indoor) 7/2009 - 9/ 2009 (Outdoor)	Investigate whether indoor and outdoor cleanup actions to date at Libby schools were sufficient to protect the health of students and staff.

LA = Libby amphibole
PCM = phase contrast microscopy
TEM = transmission electron microscopy

TABLE 2-1. DOCUMENTS GOVERNING FIELD DATA AND SAMPLE COLLECTION

Document Title	Common Name	Document Date
Sampling and Quality Assurance Project Plan for Libby, Montana, Environmental Monitoring for Asbestos, Baseline Monitoring for Source Area and Residential Exposure to Tremolite-Actinolite Asbestos Fibers	Phase 1 SQAPP	Rev 1 – 1/4/00
Export Plant Removal Action Work Plan Libby, Montana Asbestos Emergency Response Project - Draft	Export Plant Removal Action Work Plan	5/17/00
Comprehensive Site Health and Safety Program, Initial Emergency Response Action, Libby Asbestos Project, Libby, Montana	HASP	Rev 5 – 12/06
Removal Action Sampling and Analysis Plan for Confirmation Sampling of Soil and Perimeter and Personal Sampling of Air for Asbestos for OU2, Former Screening Plant Area Near Libby, Montana	OU2 SAP	Rev 1 – 9/00
Phase 2 Sampling and Quality Assurance Project Plan for Libby, Montana, Environmental Monitoring for Asbestos, Evaluation of Exposure to Airborne Asbestos Fibers During Routine and Special Activities	Phase 2 SAP/QAPP	3/01
Final Sampling and Analysis Plan, Remedial Investigation	RI SAP	5/19/03
Sampling and Analysis Plan Remedial Investigation Contaminant Screening Study, Libby Asbestos Site, OU4, Libby, Montana (with site-specific addenda)	CSS SAP	Rev 1 – 5/16/03
Sampling and Analysis Plan for Indoor Dust for Use at the Libby, Montana Superfund Site	Dust SAP	8/7/03
Pre-Design Inspection Activities Work Plan, Libby Asbestos Project, Libby, Montana	PDI Workplan	11/03
Contaminant Screening Study Final Sampling and Analysis Plan Addendum, Post Clean-up Evaluation Sampling	CSS SAP Addendum (Post Cleanup)	12/03
Contaminant Screening Study, Final Technical Memorandum, Libby Asbestos Site, Operable Unit 4	CSS Tech Memo	1/31/04
Lincoln County Class IV Asbestos Landfill Operations Plan Rev. 1	Landfill Operation Plan	2/04
Sampling and Analysis Plan for Assessing Asbestos Release from Building Demolition at the Libby, Montana Superfund Site	Demolition SAP	5/4/05
Supplemental Remedial Investigation Quality Assurance Project Plan for Libby, Montana	Supplemental QAPP, RI SQAPP	Rev 1 – 8/05
Sampling and Analysis Plan for Cumulative Inhalation Exposures in Libby, MT	Cumulative Exposure SAP	11/05
Sampling and Analysis Plan for Outdoor Ambient Air Monitoring at the Libby Asbestos Site. Revision 1	Ambient Air SAP	12/06
Technical Memorandum Wood Chip Sampling Former Stimson Lumber Yard 875 Highway 2 S, Libby Montana	OU5 Wood Chip Sampling	5/07
Libby Asbestos Project Dust Composite Sampling Pilot Study, Revision 0	Dust Composite Pilot Study	5/16/07
General Workplan for Building Demolition at the Libby, Montana Superfund Site, Revision 2	Demolition Workplan	5/17/07
Sampling and Analysis Plan for Outdoor Ambient Air Monitoring – Operable Units 1, 2, 5, and 6.	Ambient Air Supplemental SAP	7/07
Sampling and Analysis Plan for Activity-Based Outdoor Air Exposures, Operable Unit 4, Libby, Montana, Superfund Site	Outdoor OU4 ABS SAP	7/07

TABLE 2-1. DOCUMENTS GOVERNING FIELD DATA AND SAMPLE COLLECTION

Document Title	Common Name	Document Date
Sampling and Analysis Plan for Activity-Based Indoor Air Exposures, Operable Unit 4, Libby, Montana, Superfund Site	Indoor OU4 ABS SAP	7/07
Final Sampling and Analysis Plan Initial Soils Data Gap Sample Collection Operable Unit 5 – Former Stimson Lumber Mill Site, Libby Asbestos Site, Libby, Montana	OU5 Soil Data Gap SAP	9/07
Sampling and Analysis Plan, Building Data Gap Sample Collection, Operable Unit 5, Libby Asbestos Site	OU5 Data Gap/Indoor Worker SAP	11/07
Response Action Work Plan, Libby Asbestos Project, Libby, Montana (with site-specific addenda) Rev 2	RAWP	2/08
Libby Asbestos Project, Lincoln County Class IV Asbestos Landfill Operations Plan, Revision 2	Landfill Operations Plan	2/08
Response Action Sampling and Analysis Plan, Revision 1, Libby Asbestos Site, Libby, Montana	Response Action SAP	4/9/08
Sampling and Analysis Plan Addendum – Initial Soils Data Gap Sample Collection Visual Vermiculite Inspection Operable Unit 5 – Former Stimson Lumber Mill Site, Libby Asbestos Site, Libby, Montana	OU5 Soil Data Gap SAP Addendum	6/08
Sampling and Analysis Plan for the MotoX, Operable Unit 5, Libby Asbestos Site	OU5 MotoX SAP	8/08
Sampling and Analysis Plan for Outdoor Worker Exposures, Operable Unit 5, Libby Asbestos Site	OU5 Outdoor Worker SAP	9/08
Sampling and Analysis Plan for Recreational User Exposures, Operable Unit 5, Libby Asbestos Site	OU5 Outdoor Recreational User SAP	9/08
Libby Asbestos Project OU5 Activity Based Sampling Soil Pilot Study Modification to OU5 MotoX ABS SAP (SRC and CDM 2008a) OU5 Outdoor Worker ABS SAP (SRC and CDM 2008b) - Draft	OU5 ABS MotoX and Worker SAP Modification	10/08
Final Sampling and Analysis Plan Libby Public Schools - Stationary Air Sample Collection	Indoor Schools SAP	12/08
Final Sampling and Analysis Plan Libby Public Schools – Activity Based Outdoor Air Exposures	Outdoor Schools SAP	7/09

ABS = activity-based sampling
CDM = CDM Federal Programs Corporation
CSS = Contaminant Screening Study
HASP = health and safety program
MotoX = motocross
PDI = pre-design inspection
QAPP = quality assurance project plan
RAWP = response action work plan
RI = remedial investigation
SAP = sampling and analysis plan
SQAPP = supplemental quality assurance project plan

TABLE 2-2a. LIST OF MODIFICATIONS TO DOCUMENTS GOVERNING FIELD DATA AND SAMPLE COLLECTION (2001 - 2002)

LFO Form No.	Requestor	Effective Date	Description	Applicable Project QAPP	Phase 2 Scenario No.	Duration	Tech Review		QA Review		Approved by	
							Reviewer	Date	Reviewer	Date	Reviewer	Date
000001	Pam Chehaske	5/3/01	Active sampling period for simulated remodeling activity extended to include time until "Post 1" sampling started	Phase 2 SQAPP	3	Permanent	John McGuiggin	5/4/01	Mary Goldade	11/27/2001	Chris Weis	05/24/01
000002	Pam Chehaske	5/3/01	One stationary high volume air sample will be collected in the work area during the simulated remodeling activity	Phase 2 SQAPP	3	Permanent	John McGuiggin	5/4/01	Mary Goldade	5/15/2001	Chris Weis	05/24/01
000003	Pam Chehaske	5/3/01	Two Marcor personnel performing simulated remodeling activity	Phase 2 SQAPP	3	Permanent	John McGuiggin	5/4/01	Mary Goldade	5/15/2001	Chris Weis	05/24/01
000004	Pam Chehaske	5/3/01	One "Post" sample was run after the simulated remodeling activity due to time constraints	Phase 2 SQAPP	3	Temporary	John McGuiggin	5/4/01	Mary Goldade	5/15/2001	Chris Weis	05/24/01
000005	Greg Parana	5/2/01	Three additional low volume personal air samples collected on remodeler in attic. Three additional low volume personal air samples collected on the worker occupying the living space.	Phase 2 SQAPP	3	Permanent	John McGuiggin	5/4/01	Mary Goldade	5/15/2001	Chris Weis	05/24/01
000006	Greg Parana	5/2/01	Four perimeter air samples collected at each corner outside of residence to ensure fiber migration not taking place	Phase 2 SQAPP	3	Permanent	John McGuiggin	5/4/01	Mary Goldade	5/2/2001	Chris Weis	05/24/01
000007	Greg Parana	5/2/01	Two personal Hazdust samples collected. One on the remodeler in the attic, one on the worker occupying the living space.	Phase 2 SQAPP	3	Permanent	John McGuiggin	5/4/01	Mary Goldade	5/15/2001	Chris Weis	05/24/01
000008	Greg Parana	4/20/01	Sweeping, vacuuming & dusting activities will be based on specific house attributes	Phase 2 SQAPP	2	Permanent	John McGuiggin	5/4/01	Mary Goldade	3/11/2002	Chris Weis	05/24/01
000009	Pam Chehaske	5/5/01	Changed from one excursion sample per Marcor personal to three task-based samples, one for dusting, vacuuming, & sweeping	Phase 2 SQAPP	2	Permanent	John McGuiggin	5/7/01	Mary Goldade	3/12/2002	Chris Weis	03/13/02
000010	Pam Chehaske	5/7/01	Cleaning activity at this residence changed to pulling carpet and vacuuming	Phase 2 SQAPP	2	Temporary	John McGuiggin	5/11/01	Mary Goldade	5/15/2001	Chris Weis	05/24/01
000011	Daniel Smigal	6/8/01	No sweeping of the floor was done during active sampling. Dusting & vacuuming extended from 40-min to one-hour each.	Phase 2 SQAPP	2	Temporary	John McGuiggin	6/20/01	Mary Goldade	3/12/2002	Chris Weis	03/13/02
000012	Could not locate original - see binder for email documentation											
000013	Could not locate original - see binder for email documentation											
000014	Could not locate original - see binder for email documentation											
000015	Could not locate original - see binder for email documentation											
000016	Daniel Smigal	7/12/01	Personal air monitors set at higher than 0.54 min	Phase 2 SQAPP	3	Temporary	John McGuiggin	7/16/01	Mary Goldade	3/12/2002	Chris Weis	03/13/02
000017	Daniel Smigal	7/12/01	Three hour presamples & three-hour post samples in the work area not collected.	Phase 2 SQAPP	3	Temporary	John McGuiggin	7/15/01	Mary Goldade	3/12/2002	Chris Weis	03/13/02
000018	Daniel Smigal	7/12/01	Three sequential samples in the living area were not collected after work was completed.	Phase 2 SQAPP	3	Temporary	Mark Raney for John McGuiggin	7/16/01				
000019	Daniel Smigal	7/12/01	Dust monitors were not used during scenario & were returned to owner.	Phase 2 SQAPP	3	Permanent	John McGuiggin	7/16/01	Mary Goldade	3/12/2002	Chris Weis	03/13/02
000020	Pam Chehaske	8/21/01	Four stationary air monitors used instead of two for pre-, active, & post-active sampling. Monitors stationed on all four corners of the residence.	Phase 2 SQAPP	4	Permanent	John McGuiggin	8/28/01	Mary Goldade	3/12/2002	Chris Weis	03/13/02
000021	Pam Chehaske	8/21/01	Two workers in exclusion zone during rototilling. Run personal samples on both workers, including excursion sampling.	Phase 2 SQAPP	4	Permanent	John McGuiggin	8/28/01	Mary Goldade	3/12/2002	Chris Weis	03/13/02
000022	Pam Chehaske	8/21/01	No aerosol monitor used during rototilling activity.	Phase 2 SQAPP	4	Permanent	John McGuiggin	8/28/01	Mary Goldade	3/12/2002	Chris Weis	03/13/02
000023	Greg Parana	8/28/01	Black microvac sample cassette switched with cassette designated for sampling.	Phase 1 SQAPP	NA	Temporary	John McGuiggin	8/30/01	*		Chris Weis	03/13/02
000024	James Henderson	8/29/01	Locally available 0.5m filtered water will be used as disinfectant wipes instead of deionized water.	Phase 1 SQAPP, Phase 2 SQAPP, Removal Action	NA	Permanent	John McGuiggin	8/30/01	*		Chris Weis	03/13/02
000025	David Schroeder	8/30/01	End use of Field 10 numbers for soil samples.	Phase 1 SQAPP	NA	Permanent	John McGuiggin	8/30/01	*		Chris Weis	03/13/02
000026	Bernd Haneke	9/20/01	Personal potable high-volume air samplers are not used- using SKC Archeck low volume sampling pumps.	Phase 2 SQAPP	2	Permanent	John McGuiggin	9/27/01	*		*	
000027	Bernd Haneke	9/20/01	Dust monitors were not used during scenario & were returned to owner.	Phase 2 SQAPP	2	Permanent	John McGuiggin	9/27/01	*		*	
000028	Bernd Haneke	9/20/01	Dusting wall is performed with a feather-type duster.	Phase 2 SQAPP	2	Permanent	John McGuiggin	9/27/01	*		*	
000029	Greg Parana	12/4/01	Frequency of Rotometer calibration/ re-calibration will be done monthly.	Removal Action	NA	Permanent	John McGuiggin	2/25/02	*		Chris Weis	03/13/02
000030	Greg Parana	12/4/01	Eliminate ISSI-LIBBY-04: 1/18/00	Phase 1 SQAPP, Phase 2 SQAPP, Removal Action	NA	Permanent	John McGuiggin	2/25/02	*		Chris Weis	03/13/02
000031	Dee Warren	12/10/01	Modification to Phase I QAPP to update SOPs (1-3, 1-2, 2-1, 4-1, 4-2, 4-5)	Phase 1 SQAPP	NA	Permanent	John McGuiggin	2/25/02	*		Chris Weis	03/13/02
000032	Dee Warren	6/10/02	Changes to IFF and IFF Completion Guidance Documents	Final CSS SAP Rev. 1	NA	Permanent	Jeff Montera	06/11/02	George Delullo	6/12/2002	Jim Christiansen	06/11/02
000033	Dee Warren	6/10/02	Change index ID# from CSS-XXXXX to CS-XXXXX	Final CSS SAP Rev. 1	NA	Permanent	Jeff Montera	06/11/02	George Delullo	6/12/2002	Jim Christiansen	06/11/02
000034	Dee Warren	6/10/02	Changes to IFF completion procedure	Final CSS SAP Rev. 1	NA	Permanent	Jeff Montera	06/11/02	George Delullo	6/12/2002	Jim Christiansen	06/11/02
000035	Dee Warren	6/10/02	Rinsate samples will not be collected during first week of June.	Final CSS SAP Rev. 1	NA	Temporary	Jeff Montera	06/11/02	George Delullo	6/12/2002	Jim Christiansen	06/11/02
000036	Dee Warren	6/10/02	Change to Soil Field Sample Data Sheet	Final CSS SAP Rev. 1	NA	Permanent	Jeff Montera	06/11/02	George Delullo	6/12/2002	Jim Christiansen	06/11/02
000037	Dee Warren	6/10/02	Wet area from where soil samples are collected	Final CSS SAP Rev. 1	NA	Permanent	Jeff Montera	06/11/02	George Delullo	6/12/2002	Jim Christiansen	06/11/02

TABLE 2-2a. LIST OF MODIFICATIONS TO DOCUMENTS GOVERNING FIELD DATA AND SAMPLE COLLECTION (2001 - 2002)

LFO Form No.	Requestor	Effective Date	Description	Applicable Project QAPP	Phase 2 Scenario No.	Duration	Tech Review		QA Review		Approved by	
							Reviewer	Date	Reviewer	Date	Reviewer	Date
000038	Dee Warren	6/29/02	Structure sketches will only include approximate dimensions of the attic	Final CSS SAP Rev. 1	NA	Permanent	Jeff Montera	7/2/02	Krista Lippoldt	7/9/2002	Jim Christiansen	07/02/02
000039	Dee Warren	6/29/02	Change rinsate preparation method to EPA Method 100.2	Final CSS SAP Rev. 1	NA	Permanent	Jeff Montera	7/2/02	Krista Lippoldt	7/9/2002	Jim Christiansen	07/02/02
000040	Dee Warren	6/29/02	Locally available deionized or distilled water will be used to collect rinsate samples	Final CSS SAP Rev. 1	NA	Permanent	Jeff Montera	7/2/02	Krista Lippoldt	7/9/2002	Jim Christiansen	07/02/02
000041	Dee Warren	6/29/02	The same BD# will be used for apartments or businesses at the same address but the apartment or suite # will be placed in the structure description field	Final CSS SAP Rev. 1	NA	Permanent	Jeff Montera	7/2/02	Krista Lippoldt	7/9/2002	Jim Christiansen	07/02/02
000042	Dee Warren	6/29/02	Modification to IFF Form	Final CSS SAP Rev. 1		Permanent	Jeff Montera	7/2/02	Krista Lippoldt	7/9/2002	Jim Christiansen	07/02/02
000043	Dee Warren	6/29/02	Secondary structure IFF will be completed only when vermiculite is present in the secondary structure	Final CSS SAP Rev. 1	NA	Permanent	Jeff Montera	7/29/02	Krista Lippoldt	7/29/2002	Jim Christiansen	08/20/02
000044	Dee Warren	7/15/02	Alconox detergent is not used as part of the decontamination procedures and steel bushes will be used to remove gross contamination	Final CSS SAP Rev. 1	NA	Permanent	George Delullo	7/19/02	Krista Lippoldt	7/19/2002	Jim Christiansen	08/20/02
000045	Dee Warren	7/15/02	Soil samples will be shipped in cooler lined with garbage bags. The garbage bags will be sealed with a custody seal	Final CSS SAP Rev. 1	NA	Permanent	George Delullo	7/19/02	Krista Lippoldt	7/19/2002	Jim Christiansen	08/20/02
000046	Mary Goldade	7/11/02	Cores were sectioned at 1.5" intervals at Flower Lake & 0.5" intervals at St. Mary's Lake	Sediment Core Pilot Study	NA	Temporary	Mary Goldade	7/11/02	Krista Lippoldt	7/19/2002	Jim Christiansen	08/20/02
000047	Mary Goldade	7/11/02	Archived samples not retained for pilot study	Sediment Core Pilot Study	NA	Permanent	Mary Goldade	7/11/02	Krista Lippoldt	7/19/2002	Jim Christiansen	08/20/02
000048	Dee Warren	7/30/02	Addition of area for recording date of soil sample collection to the header portion of the primary IFF	CSS	NA	Permanent	Jeff Montera	7/30/02	George Delullo	8/20/2002	Jim Christiansen	08/20/02
000049	Dee Warren	9/5/02	Require printed name of author on each page of the logbook that is copied for placement in residential folders	CSS	NA	Permanent	Jeff Montera	9/9/02	Krista Lippoldt	9/9/2002	Jim Christiansen	09/17/02
000050	Dee Warren	9/5/02	Require North arrow on figures completed on IFFs	CSS	NA	Permanent	Jeff Montera	9/9/02	Krista Lippoldt	9/9/2002	Jim Christiansen	09/17/02
000051	Dee Warren	9/5/02	Determination of primary source volumes and product percentages as described in Section 4.3.3.1, page 4-5, paragraph 2 has not and will not be done	CSS	NA	Permanent	Jeff Montera	9/9/02	Krista Lippoldt	9/9/02	M. Goldade	4/10/2006 (rec'd in Libby 6/8/06)
000052	Dee Warren	9/5/02	IFFs are mailed to Volpe weekly instead of faxed daily	CSS	NA	Permanent	Jeff Montera	9/9/02	Krista Lippoldt	9/9/02	Jim Christiansen	09/17/02
000053	Dee Warren	9/5/02	Use of grid, quadrant, and section numbers will not be used. Tracking progress will be done by streets.	CSS	NA	Permanent	Jeff Montera	9/9/02	Krista Lippoldt	9/9/02	Jim Christiansen	09/17/02
000054	Dee Warren	9/5/02	Decontamination will use a plastic brush and paper towels may be used to dry equipment. Also, equipment will periodically be cleaned using Alconox.	CSS	NA	Permanent	Jeff Montera	9/9/02	Krista Lippoldt	9/9/02	Jim Christiansen	09/17/02
000055	Dee Warren	9/9/02	Modify FSDS to remove requirement grid/quadrant/section	CSS	NA	Permanent	Jeff Montera	9/10/02	Krista Lippoldt	9/10/02	Jim Christiansen	09/17/02
000056	Dee Warren	9/9/02	Changes to IFF (version 4, 8/24/02)	CSS	NA	Permanent	Jeff Montera	9/10/02	Krista Lippoldt	9/10/02	Jim Christiansen	09/17/02
000057	Dee Warren	9/13/02	Duplicate sample collection procedure added to soil sample collection SOP CDM-LIBBY-05	CSS	NA	Permanent	Jeff Montera	9/13/02	Krista Lippoldt	9/13/02	Jim Christiansen	09/17/02
000058	Dee Warren	9/13/02	Use a supplemental IFF for properties that had Background Information Field Forms completed as part of Phase 1 dust sampling program	CSS	NA	Permanent	Jeff Montera	9/13/02	Krista Lippoldt	9/13/02	Jim Christiansen	09/17/02
000059	Mary Goldade	11/4/02	Key personnel changed from P. Peronard and C. Weis to J. Christiansen and M. Goldade	PE Study	NA	Permanent	Mary Goldade	11/4/02	NA	NA	Jim Christiansen	11/04/02
000060	Dee Warren	11/12/02	Clarification in sample depth collection	CSS	NA	Permanent	Dave Schroeder	11/6/02	Doug Updike	11/18/2002	Mary Goldade	11/26/02
000061	Dee Warren	11/12/02	Clarification in origin of samples analyzed and presented in Tech Memo 11/4/02	CSS	NA	Permanent	Dave Schroeder	11/6/02	Doug Updike	11/18/2002	Mary Goldade	11/26/02
000062	Dee Warren	11/22/02	Update soil preparation SOP	CSS	NA	Permanent	Dave Schroeder	11/22/02	Laura Splichal	11/22/2002	Mary Goldade	11/26/02
000063	NOT USED											

CSS = Contaminant Screening Study
FSDS = field sample data sheet
IFF = information field form
LFO = Libby field modification
NA = not applicable
PE = performance evaluation
QAPP = quality assurance project plan
SOP = standard operating pProcedure

TABLE 2-2b. LIST OF MODIFICATIONS TO DOCUMENTS GOVERNING FIELD DATA AND SAMPLE COLLECTION (2003 - 2009)

LFO Form No.	Requestor	Date	Description	Applicable Project SAP or QAPP	Applicable SOP Number and Rev. No.	Duration	Effective Date	Ipe Or USACE Review/Approv Reviewer	Date	EPA Review/Approval Reviewer	Date
000065	Dee Warren	8/4/03	Revision to dust FSDS	Final CSS SAP, Rev. 1; Final RI SAP	NA	Permanent	6/5/03	NA (RI activity)	NA	Mary Goldade	4/10/06
000066	Dee Warren	8/4/03	Revision to the Additional Information Field Form	Final RI SAP	NA	Permanent	8/1/03	NA (RI activity)	NA	Mary Goldade	8/7/03
000067	Dee Warren	8/1/03	Clarification on reduction of dust sampling area	Final RI SAP	NA	Temporary	5/31/03 to 7/8/03	NA (RI activity)	NA	Mary Goldade	8/20/03
000068	NOT USED										
000069	Dee Warren	9/8/03	Revision to sample relinquishing procedures and documentation	Final CSS SAP, Rev. 1; Final RI SAP	CDM 1-2 Sample Custody Project-Specific Mod (5/03)	Permanent	6/5/03	NA (RI activity)	NA	Mary Goldade	6/1/06
000070	Dee Warren	9/8/03	Revision to soil sample analysis method (IR no longer used)	Final CSS SAP, Rev. 1; Final RI SAP	NA	Permanent	6/4/03	NA (RI activity)	NA	Mary Goldade	6/1/06
000071	Dee Warren	9/8/03	Clarification to sample in large use areas containing visible vermiculite but not SUAs	Final CSS SAP, Rev. 1; Final RI SAP	CDM-Libby-05 Rev. 1	Permanent	5/31/03	NA (RI activity)	NA	Mary Goldade	6/1/06
000072	NOT USED										
000073	NOT USED										
000074	Dee Warren	11/20/03	Analyze all dust samples collected under the SAP using AHERA analysis rather than ISO	CSS Addendum: Post-Cleanup Evaluation SAP	NA	Permanent	11/20/03	Mark Raney	6/13/06	Mary Goldade	6/5/06
000075	NOT USED										
000076	Thomas Cook	1/8/04	Revision to Supplemental Interior Inspection Checklist	Final Draft Pre-Design Inspection Activities Work Plan	NA	Permanent	12/15/03	Mark Raney	6/13/06	Mary Goldade	6/5/06
000077	Thomas Cook	1/8/04	Revision to Exterior Inspection Checklist	Final Draft Pre-Design Inspection Activities Work Plan	NA	Permanent	11/5/03	Mark Raney	6/13/06	Mary Goldade	6/5/06
000078	Terry Crowell	1/27/04	Counting rules clarification based on stated analytical sensitivity	CSS Addendum: Post-Cleanup Evaluation SAP	AHERA	Permanent	1/9/04	Mark Raney	6/13/06	Mary Goldade	6/5/06
000079	Terry Crowell	2/20/04	Dust samples will be prepared indirectly rather than directly	CSS Addendum: Post-Cleanup Evaluation SAP	AHERA	Permanent	2/20/04	Mark Raney	6/13/06	Mary Goldade	6/5/06
000080	Ben Shoup	3/9/05	Revision of SIIC form	Final Draft Pre-Design Inspection Activities Work Plan	NA	Permanent	3/9/05	Mark Raney	6/13/06	Mary Goldade	6/5/06
000081	Ben Shoup	3/9/05	Revision of EIC form	Final Draft Pre-Design Inspection Activities Work Plan	NA	Permanent	3/9/05	Mark Raney	6/13/06	Mary Goldade	6/5/06
000082	NOT USED										
000083	NOT USED										
000084	Terry Crowell	7/19/05	Revision to SQAPP: new field team leader appointed during field event	2005 SQAPP	NA	Permanent	7/8/05	Mark Raney	7/25/05	Mary Goldade	7/25/05
000085	Terry Crowell	7/19/05	For SQAPP Task 11, resident activity logs will not be required to be completed	2005 SQAPP	NA	Permanent	6/25/05	Mark Raney	7/25/05	Mary Goldade	7/25/05
000086	Terry Crowell	8/29/05	For SQAPP Task 9, qualifying dust sample result requirements will be adjusted	2005 SQAPP	NA	Permanent	8/30/05	Mark Raney	6/13/06	Mary Goldade	6/5/06
000087	NOT USED										
000088	Terry Crowell	1/13/06	Dust lot blanks will be submitted to the lab with matrix of "Air" to designate direct preparation of the samples	Final RI SAP; Final Draft Pre-Design Inspection Activities Work Plan	NA	Permanent	6/18/03	Mark Raney	6/13/06	Mary Goldade	6/5/06
000089	Nick Raines	3/24/06	Specific-use areas will be sampled per SOP CDM-LIBBY-05 Rev. 1 regardless of the presence of Libby vermiculite	Final Draft PDIAWP, 11/03	NA	Temporary	4/27/06	in review - 12/06		Mary Goldade	12/5/06
000089 Revision 1	Nick Raines	4/9/07	Revokes LFO-000089 to sample SUAs with visible vermiculite	Final Draft PDIAWP, 11/03	NA	Permanent	4/10/07	in review - 12/06		in review - 12/06	
000090	Terry Crowell	3/23/06	The QAPP will be modified to reference procedures detailed in the CSS/RI SAP Rev. 1 (5/03) rather than the CSS SAP (4/02)	Draft Final PDIAWP, 11/03	NA	Permanent	11/03	in review - 12/06		Mary Goldade	12/5/06
000091	Terry Crowell	3/23/06	Proposal to collect soil QC samples at stated frequencies	Draft Final PDIAWP, 11/03	NA	Permanent	3/27/06	in review - 12/06		Mary Goldade	12/5/06
000092	Terry Crowell	3/23/06	When the QAPP is revised (anticipated early 2008), it will be modified to consistently reference project-approved sample custody procedures	Draft Final RAWP, 11/03	NA	Permanent	11/03	in review - 12/06		Mary Goldade	12/5/06
000093	Terry Crowell	4/7/06	The QAPPs will be modified to include revised FSDSs for soil and stationary air that include fields to track GPS point collection	All QAPPs governing sample collection of soil and stationary air	NA	Permanent	4/13/06	Pat Carnes	4/12/06	Mary Goldade	12/5/06
000093 Revision 1	Diane Rode	4/13/09	Changes to FSDS and SOP	All QAPPs governing sample collection of soil, personal air and stationary air	NA	Permanent	4/1409	in review - 4/09		in review - 4/09	
000094	Terry Crowell	4/10/06	No field blanks were collected for the pilot cumulative personal air monitoring study	Draft Cumulative Exposure Monitoring Study (v3 11/5/05)	NA	Temporary	11/8/05	in review - 12/06		Mary Goldade	12/5/06

TABLE 2-2b. LIST OF MODIFICATIONS TO DOCUMENTS GOVERNING FIELD DATA AND SAMPLE COLLECTION (2003 - 2009)

LFO Form No.	Requestor	Date	Description	Applicable Project SAP or QAPP	Applicable SOP Number and Rev. No.	Duration	Effective Date	Ipe Or USACE Review/Approv Reviewer	Date	EPA Review/Approval Reviewer	Date
000095	Kathryn Tenney	4/12/06	Volumes of less than the recommended 1,200 L were collected for 3 of 5 stationary air clearance samples	Draft Final RAWP, 11/03	AHERA guidance, 40 CFR, Chapter 1, Subchapter R, Part 763, Subpart E, Appendix A	Temporary	4/12/06	in review - 12/06		Mary Goldade	12/5/06
000096	Terry Crowell	4/17/06	Selection of properties for SQAPP sampling is independent of dust sample collection technique used to obtain investigation dust sampling results	Final Supplemental RI QAPP (SQAPP), 6/06	NA	Permanent	8/30/05	in review - 12/06		Mary Goldade	12/5/06
000097	Terry Crowell	5/25/06	CSSs were conducted at properties that lie outside the established OU4 boundary 5/08 NOTE: this mod is no longer applicable based on EPA's decision to expand OU4 boundaries	Final CSS SAP, 5/02 and Final RI SAP Rev. 1, 5/03	NA	Permanent	5/02	in review - 12/06		Mary Goldade	12/5/06
000098	Laurance Goodman	7/21/06	Volumes of less than the recommended 1,200 L were collected for 2 of 5 stationary air clearance samples	Draft Final RAWP, 11/03	AHERA guidance, 40 CFR, Part 763, Subpart E, Appendix A	Temporary	7/21/06	in review - 12/06		Mary Goldade	12/5/06
000099	Thomas Cook	12/27/06	The Eureka MET station (BLM/USFS station) didn't record data from 11/27 - 12/4/06, 12/20/06, and part of 12/21/06	Ambient Air SAP Rev. 0, 9/28/06; Ambient Air SAP Rev 1, 12/7/06	CDM-LIBBY-12, Rev. 0; CDM-LIBBY-12, Rev. 1	Temporary	11/27 - 12/4/06, 12/20/06, and part of 12/21/06	in review - 1/07		in review - 1/07	
000100	Thomas Cook	12/27/06	Explanation of variations in actual sample collection times versus recorded sample collection times for ambient air samples collected between 10/3 and 12/4/06	Ambient Air SAP Rev. 0, 9/28/06	CDM-LIBBY-12, Rev. 0	Temporary	10/3 - 12/4/06	in review - 1/07		in review - 1/07	
000101	Thomas Cook	12/29/06	Additional field blanks were collected during events 7 and 8 at Libby locations specified in the mod	Ambient Air SAP Rev 1, 12/7/06	CDM-LIBBY-12, Rev. 1	Temporary	12/8 - 12/24/06	in review - 1/07		in review - 1/07	
000102	Damon Repine	1/16/07	Flow rates for the Helena location have been adjusted	Ambient Air SAP Rev. 0, 9/28/06	CDM-LIBBY-12, Rev. 0	Permanent	10/8/06	in review - 1/07		in review - 1/07	
000103	Thomas Cook	2/28/07	Eureka MET station did not collect data on 1/2/07, 1/3/07, 1/11 - 1/16/07, and 1/22/07	Ambient Air SAP Rev 1, 12/7/06	CDM-LIBBY-12, Rev. 1	Temporary	see description	in review - 2/07		in review - 2/07	
000104	Thomas Cook	3/13/07	Eureka MET station did not collect data on 2/05 - 2/08/07 and 2/12 - 2/15/07	Ambient Air SAP Rev 1, 12/7/06	CDM-LIBBY-12, Rev. 1	Temporary	see description	in review - 2/07		in review - 2/07	
000105	Terry Crowell	5/9/07	Soil equipment blanks will no longer be collected	Phase 1 QAPP, 3/00; RI SAP Rev. 1, 5/02; Draft Final PDIAWP, 11/03; Draft Indoor ABS SAP, 4/18/07; Draft Outdoor ABS SAP, 4/18/07	N/A	Permanent	5/14/07	in review - 5/07		in review - 5/07	
000107	Nick Raines	5/25/07	PDI soil sampling will be conducted in accordance with CDM-LIBBY-05, Revision 2 with exceptions as stated in the mod	Draft Final PDIAWP, 11/03	CDM-LIBBY-05, Rev. 2	Temporary	5/29 - 6/17/07	in review - 10/07		in review - 10/07	
000107 Rev 1	Nick Raines	6/15/07	PDI soil sampling will be conducted in accordance with CDM-LIBBY-05, Revision 2 with revised exceptions as stated in the mod	Draft Final PDIAWP, 11/03	CDM-LIBBY-05, Rev. 2	Permanent	6/18/07	in review - 10/07		in review - 10/07	
000109*	Thomas Cook	12/4/07	Increases the number and collection frequency of settled dust samples *form number changed from 000127 to prevent form duplication	Building Data Gap Sample Collection - OU5, 11/2/07	NA	Permanent	11/30/2007	Amishi Castelli	12/4/07	in review - 12/07	
000110	Mark Hatcher	5/31/07	Eureka MET station did not collect data on 5/23 and 5/24/07	Ambient Air SAP Rev. 1, 12/7/06	CDM-LIBBY-12, Rev. 1	Temporary	see description	in review - 6/07		in review - 6/07	
000111	Karen Repine	9/21/07	Documents administrative changes to the RAWP SAP, including sample labels, photo naming convention, and correction to the table of contents	Draft Final RAWP, 11/03; RAWP Rev. 1, 4/07	NA	Permanent	11/03 for Index IDs and editorial edits; 9/21/07 for photos	in review - 9/07		in review - 9/07	
000112*	Mark Hatcher	1/23/08	Changes in dustfall analytical procedure *form number changed from 000128 to prevent form duplication	Building Data Gap Sample Collection - OU5, 11/2/07	NA	Permanent	12/1/2007	in review - 12/07		in review - 12/07	
000113	Nicole Bielecki	9/19/07	MET stations for Outdoor ABS will collect data at 60-second intervals rather than 30-second intervals	Final Outdoor ABS SAP, 7/6/07	N/A	Permanent	7/9/07	in review - 10/07		in review - 10/07	
000114	Nicole Bielecki	9/19/07	Low volume sampling pumps for collecting personal air samples will be set at a target flow rate of 3.0 L/min rather than 3.5 L/min to avoid pump failure	Final Outdoor ABS SAP, 7/6/07	N/A	Permanent	7/18/07	in review - 10/07		in review - 10/07	
000115	Nicole Bielecki	9/19/07	Low volume sampling pumps for collecting personal air samples will be set at a target flow rate of 3.0 L/min rather than 3.5 L/min to avoid pump failure	Final Indoor ABS SAP, 7/6/07	N/A	Permanent	7/18/07	in review - 10/07		in review - 10/07	

TABLE 2-2b. LIST OF MODIFICATIONS TO DOCUMENTS GOVERNING FIELD DATA AND SAMPLE COLLECTION (2003 - 2009)

LFO Form No.	Requestor	Date	Description	Applicable Project SAP or QAPP	Applicable SOP Number and Rev. No.	Duration	Effective Date	Ipe Or USACE Review/Approv Reviewer	Date	EPA Review/Approval Reviewer	Date
000116	Nicole Bielecki	9/19/07	Mod to CDM-Libby-10, Rev. 1 for Indoor ABS only: one dust sample will be collected per ABS house rather than one per living floor	Final Indoor ABS SAP, 7/6/07	CDM-Libby-10, Rev. 1	Permanent	727/07	in review - 10/07		in review - 10/07	
000117	Nicole Bielecki	9/19/07	The period for conducting indoor sampling activities may be split over weekends to accommodate residents' schedules rather than conducting the sampling over one 8-hour period	Final Indoor ABS SAP, 7/6/07	N/A	Permanent	9/21/07	in review - 10/07		in review - 10/07	
000118	Nicole Bielecki	9/21/07	For the Spring 2008 outdoor ABS sampling, sampling will not occur if rainfall has exceeded 1/4 inch in 36 hours 4/08 NOTE: no longer applies as documented in LFO-000128	Final Outdoor ABS SAP, 7/6/07	N/A	Permanent	9/21/07	NOT USED - Notified by N. Bein on 4/16/08		NOT USED - Notified by N. Bein on 4/16/08	
000119	Bill Brattin	9/26/07	Reduces the number of ambient air sampling locations	Ambient Air SAP Rev. 1, 12/7/06	N/A	Permanent	10/1/07	in review - 9/07		in review - 9/07	
000120	Nick Raines	7/27/07	Changes the default design excavation depth for SUAs, with the exception of gardens, to 12" below ground surface	Draft Final PDIAWP, 11/03	N/A	Permanent	7/30/07	in review - 10/07		in review - 10/07	
000121	Nick Raines	7/27/07	Dust samples will no longer be collected during PDIs	Draft Final PDIAWP, 11/03	N/A	Permanent	7/30/07	in review - 10/07		in review - 10/07	
000122	Nick Raines	5/25/07	Implements 30-point visual inspection process during PDIs using CDM-LIBBY-06, Revision 1	Draft Final PDIAWP, 11/03	CDM-LIBBY-06, Rev. 1	Temporary	5/29 - 6/17/07	in review - 10/07		in review - 10/07	
000122 Revision 1	Nick Raines	5/25/07	For certain use types, decreases the visual inspection density	Draft Final PDIAWP, 11/03	CDM-LIBBY-06, Rev. 1	Permanent	6/18/07	in review - 10/07		in review - 10/07	
000123	Nick Raines	9/25/07	Driveways will be included as SUAs during PDIs	Draft Final PDIAWP, 11/03	NA	Permanent	5/29/07	in review - 10/07		in review - 10/07	
000124	Terry Crowell	9/27/07	PDI inspection information will be captured electronically using portable field laptops versus hardcopy forms	Draft Final PDIAWP, 11/03	NA	Permanent	9/04	in review - 10/07		in review - 10/07	
000125	NOT USED										
000126	NOT USED										
000128	N. Bein	4/16/08	Various changes to exterior ABS sample collection and analysis	Final Outdoor ABS SAP, 7/6/07	NA	Permanent	various - see mod form attachment 1	in review - 4/08		in review - 4/08	
000129	N. Bein	4/16/08	Personal air samples used for OSHA monitoring will be collected and analyzed in accordance with the RA SAP, Revision 1 dated 4/9/08	Final Outdoor ABS SAP, 7/6/07 Final Indoor ABS SAP, 7/6/07	NA	Permanent	7/9/07	in review - 4/08		in review - 4/08	
000130	N. Bein	4/16/08	Various mods to ABS procedures	Final Outdoor ABS SAP, 7/6/07 Final Indoor ABS SAP, 7/6/07 OU1 Data Gap SAP, 9/10/07 OU5 Building Data Gap SAP, 11/2/07	NA	Permanent	various - see mod form attachment 1	in review - 4/08		in review - 4/08	
000131	N. Bein	4/16/08	Field duplicates will be collected at a 5% frequency	Final Indoor ABS SAP, 7/6/07 OU5 Building Data Gap SAP, 11/2/07 Draft Site-wide QAPP, 1/23/07	NA	Permanent	7/9/07	in review - 4/08		in review - 4/08	
000132	N. Bein	7/10/08	Two additional grids within the area of the former nursery shed will be sampled to support future ABS activity in those areas	Addendum - Initial Soils Data Gap Collection Visible Vermiculite Inspection Operable Unit 5 (OU5)- Former Stimson Lumber Mill Site, 6/13/08	NA	Permanent	7/11/08	in review - 7/08		in review - 7/08	
000134	N. Bein	8/20/08	**Section 5.3.1**. Analysis of field samples will continue until the target sensitivity is achieved, 50 LA structures are observed or 0.8 mm^2 of the filter is evaluated. **Section 5.3.2**. Analysis of Field Blanks and Lot Blanks will continue until 0.1 mm^2 of the filter is evaluated. Refer to OU5MOTOX, Revision1.	Final SAP for OU5 MotoX Track	NA	Permanent	9/8/08	Amishi Castelli	9/5/08	Kathy Hernandez	9/5/08
000135	Keller Schnier	10/10/08	Volumes of less than the recommended 1,200 L were collected for 5 of 5 stationary air clearance samples	Response Action Sampling and Analysis Plan, Revision 1 April 2008	AHERA guidance, 40 CFR, Part 763, Subpart E, Appendix A	Temporary	10/10/08	in review - 10/08		in review - 10/08	
000136	Steve McNally	10/21/08	Seven specific-use areas (SUAs) were combined into one confirmation soil sample rather than the maximum of five SUAs as required in the RA SAP	Response Action Sampling and Analysis Plan, Revision 1 April 2008	NA	Temporary		in review - 11/08		in review - 11/08	
000137	Kevin Williamson	10/15/08	Six specific-use areas (SUAs) were combined into one confirmation soil sample rather than the maximum of five SUAs as required in the RA SAP	Response Action Sampling and Analysis Plan, Revision 1 April 2008	NA	Temporary		in review - 11/08		in review - 11/08	

TABLE 2-2b. LIST OF MODIFICATIONS TO DOCUMENTS GOVERNING FIELD DATA AND SAMPLE COLLECTION (2003 - 2009)

LFO Form No.	Requestor	Date	Description	Applicable Project SAP or QAPP	Applicable SOP Number and Rev. No.	Duration	Effective Date	Volpe Or USACE Review/Approv Reviewer	Volpe Or USACE Review/Approv Date	EPA Review/Approval Reviewer	EPA Review/Approval Date
000138	Nicole Bein	10/22/08	Ashing blanks will be created and inserted into the prep process for vegetations samples collected as part of the OU5 pilot study	OU5 Activity Based Sampling Soil Pilot Study, Modification to OU5 MotoX ABS SAP and OU5 Outdoor Worker ABS SAP (10/6/08)	NA	Permanent	10/17/08	Amishi Castelli	10/27/08	following Volpe approval, changes were incorporated into document revision - Soil Pilot Study SAP, Rev. 1, 11/28/08	
000139	Nicole Bein	10/22/08	Only the vegetation samples with fibrous root systems will be prepped and analyzed	OU5 Activity Based Sampling Soil Pilot Study, Modification to OU5 MotoX ABS SAP and OU5 Outdoor Worker ABS SAP, 10/6/08	NA	Permanent	10/17/08	Amishi Castelli	10/27/08	following Volpe approval, changes were incorporated into document revision - Soil Pilot Study SAP, Rev. 1, 11/28/08	
000141	Nicole Bein	1/15/09	Details the changes to the phased approach for fluidized bed and PLM-VE analysis of the OU5 soil pilot study samples	OU5 Activity Based Sampling Soil Pilot Study, Modification to OU5 MotoX ABS SAP and OU5 Outdoor Worker ABS SAP, Revision 1, 11/28/08	NA	Permanent	1/15/09	Amishi Castelli	1/22/09	Stan Christiansen	1/22/09
000143	Damon Repine	3/11/09	Amendment March 2009- Detail of changes to the Response Action Work Plan February 2008	Response Action Work Plan - 2/2008	NA	Permanent	3/18/09	Courtney Zamora	3/12/09	Mike Cirian	3/17/09
000145	Nicole Bein	4/13/09	Fluidized Beds	OU5 Motox ABS SAP OU5 Outdoor Worker ABS SAP Rev. 1 (11/28/08)	NA	Permanent	5/11/09	Amishi Castelli	5/13/09	Stan Christiansen	5/13/09
000146	Nicole Bein	4/14/09	Stationary Air Locations for School Samples	Libby Public Schools - Stationary Air Sample Collection SAP (12/5/08)	NA	Permanent	12/8/08	Mark Raney	5/1/09	Mike Cirian	5/1/09
000147	Matthew Forkel	7/20/09	Volumes of less than the recommended 1,200 L were collected for 5 of 5 stationary air clearance samples	Response Action Sampling and Analysis Plan, Revision 1 April 2008	AHERA guidance, 40 CFR, Part 763, Subpart E, Appendix A	Temporary	7/20/09	Mark Raney	8/4/09	Mike Cirian	8/6/09
000148	NOT USED										

ABS = activity-based sampling
AHERA = Asbestos Hazard Emergency Response Act
CSS = Contaminant Screening Study
EIC = exterior inspection checklist
EPA = Environmental Protection Agency
FSDS = field sample data sheet
GPS = global positioning system
IFF = information field form
ISO = International Organization for Standardization
LFO = Libby field modification
MET = meteorlogical station
MOD = modification
Motox = motocross
NA = not applicable
OSHA = Occupational Safety and Health Administration
PDI = pre-design inspection
PE = performance evaluation
PLM-VE = polarized light microscopy visual area estimation
QAPP = Quality Assurance Project Plan
QC = quality control
RAWP = response action work plan
RI = remedial investigation
SAP = sampling and analysis plan
SIIC = supplemental interior inspection checklist
SOP = standard operating procedure
SQAPP = supplemental quality assurance project plan
Volpe = John A. Volpe National Systems Transportation Center

TABLE 3-1. CSF MODIFICATIONS SUMMARY

Modification No.	Description of Deviation	Effective Date	Applicable CSF SPP Section
0001	Change to Libby QAM report	6/20/03	Appendix A
0002	Change to procedure for recording duplicate samples on Preparation Sample Data Sheets (PSDS)	10/13/03	Section 3.1.1
0003	Change to the Standard Operating Procedure (SOP) number for the CSF eLASTIC module	10/29/03	Appendix C
0004	Change to oven size and procedure for drying samples	7/7/03	Appendix B
0005	Change to use of disposable mops and wipes for decontamination procedures	7/7/03	Section 3.3
0006	VOID, Mod was eliminated because information was repeated in Mod # 00015	N/A	N/A
0007	Change to the procedure for recording and transferring duplicate sample information to Volpe	4/15/03 - 7/7/03	Section 3.1.1
0008	Change in title of Field Sample Data Sheet (FSDS) to Preparation Data Sample Sheet (PSDS)	7/3/03	Section 3.1.1 and 3.4.5.4
0009	Change to type of soil used to calibrate the grinder at the CSF	7/30/03	Appendix B
0010	Addition of the CSF office to the laboratory housekeeping schedule	7/7/03	Section 3.3
0011	Change to the preparation log sheets	8/1/03	Appendix B
0012	Change to procedure for preparing duplicate samples	8/5/03	Appendix B
0013	Addition of equipment to the CSF lab	7/3/03	Section 3.2
0014	Change in assignment of preparation duplicate samples to their parents	5/21/03	Appendix C
0015	Documentation of proper sealing and storing of dried samples	12/1/99 - 7/7/03	Appendix B
0016	Change in analysis frequency of duplicate samples created during the effective date	12/1/99 - 5/20/03	N/A
0017	Explanation of re-drying process	7/7/03	N/A

CSF = Close Support Facility

N/A = not applicable

QAM = quality Assurance manager

SPP = soil preparation plan

TABLE 3-2. EVALUATION CRITERIA FOR CSF MONITORING SAMPLES

Acceptance Criteria	Corrective Action
Ambient Air Samples	
PCM ≤ 0.01 s/cc TEM ≤ 1 LA structure	CSF laboratory will be wet-wiped and HEPA vacuumed and ambient air samples recollected. If the second set of samples exceeds the evaluation criteria, sample preparation will be stopped and a review of engineering controls and work practices will be held with CDM, EPA, and Volpe.
Personal Air Samples	
PCM ≤ 0.05 s/cc (a) TEM ≤ 0.1 LA s/cc (length 0.5-5µm) TEM ≤ 0.01 LA s/cc (length > 5µm)	CSF laboratory will be wet-wiped and HEPA vacuumed and personal air samples recollected. If the second set of samples exceeds the evaluation criteria, sample preparation will be stopped and a review of engineering controls and work practices will be held with CDM, EPA, and Volpe.
Microvacuum Dust Samples	
TEM ≤ 5,000 LA s/cm^2 (b)	CSF laboratory will be wet-wiped and HEPA vacuumed and dust samples recollected. If the second set of samples exceeds the evaluation criteria, sample preparation will be stopped and a review of engineering controls and work practices will be held with CDM, EPA, and Volpe.

(a) Criteria is equal to one-half the OSHA permissible exposure limit (PEL) of 0.1 s/cc
(b) Criteria is the dust action level for Libby residents (EPA 2005) and representative of a safe working environment in modified Level D personal protective equipment (PPE).

≤ = less than or equal to
µm = micrometers
CDM = CDM Federal Programs Corporation
CSF = Close Support Facility
EPA = Environmental Protection Agency
HEPA = high-efficiency particulate air
LA = Libby amphibole
OSHA = Occupational Safety and Health Administration
PCM = phase contrast microscopy
s/cc = structures per cubic centimeter
s/cm^2 = structures per square centimeter
TEM = transmission electron microscopy
Volpe = John A. Volpe National Systems Transportation Center

TABLE 3-3. CSF AIR AND DUST MONITORING SAMPLES

Panel A: TEM Results

Medium		Year	Number of Samples	Number of Samples with Detected LA	LA Detection Frequency	Range of Detected Total LA Values (air conc - s/cc, dust loading - s/cm^2)	
						Minimum	Maximum
Air	Personal	2003*	36	0	0%	--	--
		2004	36	1	3%	0.018	0.018
		2005	6	0	0%	--	--
		2006	19	0	0%	--	--
		2007	12	0	0%	--	--
		2008	2	0	0%	--	--
		2009	4	0	0%	--	--
	Ambient Stationary	2003*	35	1	3%	0.0045	0.0045
		2004	39	3	8%	0.0014	0.0017
		2005	12	0	0%	--	--
		2006	24	0	0%	--	--
		2007	12	0	0%	--	--
		2008	8	0	0%	--	--
		2009	4	1	25%	0.0019	0.0019
Dust		2003	42	0	0%	--	--
		2004	60	4	7%	487	1218
		2005	18	0	0%	--	--
		2006	34	0	0%	--	--
		2007	12	0	0%	--	--
		2008	12	0	0%	--	--
		2009	6	0	0%	--	--

Panel B: PCM Results

Medium		Year	Number of Samples	Number of Detected Samples	Detection Frequency	Range of Detected Air Concentration Values (s/cc)	
						Minimum	Maximum
Air	Personal	2003*	36	25	69%	0.003	0.10
		2004	32	18	56%	0.003	0.36
		2005	8	1	13%	0.007	0.007
		2006	20	4	20%	0.019	0.12
		2007	12	8	67%	0.007	0.49
		2008	6	2	33%	0.004	0.012
		2009	4	0	0%	--	--
	Ambient Stationary	2003*	24	15	63%	0.0008	0.004
		2004	32	16	50%	0.0009	0.004
		2005	8	0	0%	--	--
		2006	24	8	33%	0.0007	0.006
		2007	12	5	42%	0.0010	0.012
		2008	4	4	100%	0.0011	0.003
		2009	4	1	25%	0.0010	0.0010

Libby2DB Download: 12/8/09.

*Only includes analyses performed post-May 2003.

-- = samples were not detected.

LA = Libby amphibole

PCM = phase contrast microscopy

s/cc =structures per cubic centimeter

s/cm^2 = structures per square centimeter

TEM = transmission electron microscopy

TABLE 4-1. NIST ASBESTOS SRMs

SRM Number	SRM Name	Asbestos Mineral(s)	Description	NIST Intended Use	Certification Date[b]
1866	Common Commercial Asbestos	Chrysotile Grunerite (Amosite) Riebeckite	Set of three bulk commercial mine-grade asbestos.	Training and QA activities associated with PLM analysis.	June 1991
1867[a]	Uncommon Commercial Asbestos	Anthophyllite Tremolite Actinolite	Set of three bulk commercial mine-grade asbestos. Termed "uncommon" because they are uncommon additions to building materials.	Calibration standards for identification of the listed asbestos minerals via PLM	August 1993
1876[b]	Chrysotile Asbestos	Chyrsotile	3x3 section of chrysotile deposited onto an MCE filter.	Count & identify chrysotile fibers on MCE filters using TEM. Training and QA activities associated with PLM analysis.	January 1992
8411	Mixed Asbestos Research Filter	Chrysotile Grunerite	Asbestos materials loaded onto an MCE filter that has been collapsed onto a glass microscopic slide.	Training in preparation of MCE filters and analytical procedures for PLM, SEM, TEM.	November 1988
2063[a]	Microanalysis Thin Film Mg-Si-Ca-Fe	NA; Elements of interest: Mg-Si-Ca-Fe-O	Mineral glass (thin film) containing elements of interest in calibrating XRF analysis.	Standardization of chemical analysis via XRF using AEM.	February 1993

[a] SRM 1867 was replaced with 1867a in March 2003. There are no differences in SRM name, asbestos minerals, description, or intended use. However, the updated certificate of analysis adds: "…materials contained in this SRM are single representatives of their mineral types and cannot represent all the variability inherent to these mineral species."

[b] For SRM 8411 this is termed a Report of Investigation date.

AEM = analytical electron microscopy
MCE = mixed cellulose ester
NA = not applicable
NIST = National Institute of Standards and Technology
PLM = polarized light microscopy
QA = quality assurance
SRM = standard reference material
XRF = x-ray flourescence

TABLE 4-2. SUMMARY OF LABORATORY MODIFICATIONS

Modification No.	Method	Description of Modification	Laboratory Applicability	Duration	Date Issued	Effective Date	Date Superceded	Prepared by:	Applicable to:	Data Quality Indicator	Status
LB-000001	TEM ISO 10312	Original data recorded using historical laboratory nomenclature at RESI. Data sheets updated to ISO 10312 nomenclature and empty fields were filled in and data was entered into the Excel spreadsheet	COCs: 03213, 03193, 03194, 03195, and 03196	Temporary	10/29/2002	_		J. Orr/Reservoirs	RES 67867	No Bias	Final
LB-000002	TEM ISO 10312	Original data recorded using historical laboratory nomenclature at RESI. Data sheets updated to ISO 10312 nomenclature and empty fields were filled in and data was entered into the Excel spreadsheet	Phase 1 data set. COC n/a	Temporary	10/29/2002	_		J. Orr/Reservoirs	RES 72240	No Bias	Final
LB-000003	TEM ISO 10312	Original data recorded using historical laboratory nomenclature at RESI. Data sheets updated to ISO 10312 nomenclature and empty fields were filled in and data was entered into the Excel spreadsheet	Phase 1 data set. COC n/a	Temporary	10/29/2002	_		J. Orr/Reservoirs	RES 72242	No Bias	Final
LB-000004	TEM ISO 10312	Original data recorded using historical laboratory nomenclature at RESI. Data sheets updated to ISO 10312 nomenclature and empty fields were filled in and data was entered into the Excel spreadsheet	Phase 1 data set. COC n/a	Temporary	10/29/2002	_		J. Orr/Reservoirs	RES 74033	No Bias	Final
LB-000005	TEM ISO 10312	Original data recorded using historical laboratory nomenclature at RESI. Data sheets updated to ISO 10312 nomenclature and empty fields were filled in and data was entered into the Excel spreadsheet	Phase 1 data set. COC n/a	Temporary	10/29/2002	_		J. Orr/Reservoirs	RES 74035	No Bias	Final
LB-000006	TEM ISO 10312	Original data recorded using historical laboratory nomenclature at RESI. Data sheets updated to ISO 10312 nomenclature and empty fields were filled in and data was entered into the Excel spreadsheet	Phase 1 data set. COC n/a	Temporary	10/29/2002	_		J. Orr/Reservoirs	RES 74036	No Bias	Final
LB-000007	TEM ISO 10312	Original data recorded using historical laboratory nomenclature at RESI. Data sheets updated to ISO 10312 nomenclature and empty fields were filled in and data was entered into the Excel spreadsheet	Phase 1 data set. COC n/a	Temporary	10/29/2002	_		J. Orr/Reservoirs	RES 74037	No Bias	Final
LB-000008	TEM ISO 10312	Original data recorded using historical laboratory nomenclature at RESI. Data sheets updated to ISO 10312 nomenclature and empty fields were filled in and data was entered into the Excel spreadsheet	Phase 1 data set. COC n/a	Temporary	10/29/2002	_		J. Orr/Reservoirs	RES 74038	No Bias	Final
LB-000009	TEM ISO 10312	Original data recorded using historical laboratory nomenclature at RESI. Data sheets updated to ISO 10312 nomenclature and empty fields were filled in and data was entered into the Excel spreadsheet	Phase 1 data set. COC n/a	Temporary	10/29/2002	_		J. Orr/Reservoirs	RES 74157	No Bias	Final
LB-000010	TEM ISO 10312	Original data recorded using historical laboratory nomenclature at RESI. Data sheets updated to ISO 10312 nomenclature and empty fields were filled in and data was entered into the Excel spreadsheet	Phase 1 data set. COC n/a	Temporary	10/29/2002	_		J. Orr/Reservoirs	RES 74158	No Bias	Final
LB-000011	TEM ISO 10312	Original data recorded using historical laboratory nomenclature at RESI. Data sheets updated to ISO 10312 nomenclature and empty fields were filled in and data was entered into the Excel spreadsheet	Phase 1 data set. COC n/a	Temporary	10/29/2002	_		J. Orr/Reservoirs	RES 74159	No Bias	Final
LB-000012	TEM ISO 10312	Original data recorded using historical laboratory nomenclature at RESI. Data sheets updated to ISO 10312 nomenclature and empty fields were filled in and data was entered into the Excel spreadsheet	Phase 1 data set. COC n/a	Temporary	10/29/2002	_		J. Orr/Reservoirs	RES 74160	No Bias	Final
LB-000013	TEM ISO 10312	Original data recorded using historical laboratory nomenclature at RESI. Data sheets updated to ISO 10312 nomenclature and empty fields were filled in and data was entered into the Excel spreadsheet	Phase 1 data set. COC n/a	Temporary	10/29/2002	_		J. Orr/Reservoirs	RES 74409	No Bias	Final
LB-000014	TEM ISO 10312	Original data recorded using historical laboratory nomenclature at RESI. Data sheets updated to ISO 10312 nomenclature and empty fields were filled in and data was entered into the Excel spreadsheet	Phase 2 data set. COC n/a	Temporary	10/29/2002	_		J. Orr/Reservoirs	RES 76750	No Bias	Final
LB-000015	PCM-NIOSH 7400	Permanent modifications and clarifications to the Phase Contrast Microscopy analysis of air samples using NIOSH 7400	All	Permanent	10/30/02	Historic		J. Orr/Reservoirs	All data reports	No Bias	Final
LB-000016	TEM ISO 10312	Permanent modifications and clarifications to the Transmission Electron Microscopy analysis of air samples using ISO 10312	All	Permanent	12/2/02	Historic	8/29/2006	J. Orr/Reservoirs	All data reports	No Bias	Final
LB-000016a	TEM ISO 10312	Counting rule clarification to TEM analysis of air samples using ISO 10312	All	Permanent	4/10/08	8/29/2006 Historic	superceded by LB-000084 (1-29-08)	L Woodbury / SRC	All data reports	Low and High Bias	Waiting for signatures (Apr 08)
LB-000016b	TEM ISO 10312	Counting rule clarification to TEM analysis of air samples using ISO 10312	Batta	Permanent	9/26/2006 (appends to LB-000016a)	Historic		B. Li / Batta	Batta reports	High Bias	Waiting for signatures (Apr 08)
LB-000016c	TEM ISO 10312	Counting rule clarification to TEM analysis of air samples using ISO 10312	EMSL	Permanent	9/27/2006 (appends to LB-000016a)	Historic		E. Cahill / EMSL	EMSL reports	No Bias	Waiting for signatures (Apr 08)
LB-000016d	TEM ISO 10312	Counting rule clarification to TEM analysis of air samples using ISO 10312	Hygeia	Permanent	9/22/2006 (appends to LB-000016a)	Historic		K. Corbin / Hygeia Laboratories, Inc.	Hygeia reports	No Bias	Waiting for signatures (Apr 08)

TABLE 4-2. SUMMARY OF LABORATORY MODIFICATIONS

Modification No.	Method	Description of Modification	Laboratory Applicability	Duration	Date Issued	Effective Date	Date Superceded	Prepared by:	Applicable to:	Data Quality Indicator	Status
LB-000016e	TEM ISO 10312	Counting rule clarification to TEM analysis of air samples using ISO 10312	MAS	Permanent	12/7/2006 (appends to LB-000016a)	Historic		M. Mount / MAS	MAS reports	No Bias	Waiting for signatures (Apr 08)
LB-000016f	TEM ISO 10312	Counting rule clarification to TEM analysis of air samples using ISO 10312	Reservoirs	Permanent	12/12/2006 (appends to LB-000016a)	Historic		J. Orr / Reservoirs	Reservoirs reports	No Bias	Waiting for signatures (Apr 08)
LB-000017	TEM AHERA	Permanent modifications and clarifications to the Transmission Electron Microscopy analysis of air sample using AHERA	All	Permanent	12/2/02	Historic	see LB-000031a	J. Orr/Reservoirs	All data reports	No Bias	Final
LB-000017a	TEM AHERA	Permanent modifications and clarifications to the Transmission Electron Microscopy analysis of air sample using AHERA	All	Permanent	8/25/03	1/23/2002	see LB-000031a / LB-000084 (1-29-08)	R. Mahoney / EMSL	All data reports	No Bias	Final
LB-000018	PLM	PLM analysis performed by EPA 600/R-93/116 rather than NIOSH 9002	All	Permanent	12/3/2002	May-02		K. Corbin/ Hygeia	Hygiea reports: 22887020057 and 2287020664	No Bias	Final
LB-000019	All TEM methodologies	Clarification of bench sheet recording format for grid openings in which no countable structures are recorded.	EMSL	Permanent	1/21/2003	1/21/2003		R. Mahoney/ EMSL	All data reports	No Bias	Final
LB-000020	EPA/600/R-94/134 (TEM Water Method 100.2)	Clarification of the data enumeration, recording, and reporting formats for EPA/600/R-94/134 (TEM Water Method 100.2) as they relate to the EPA Region 8 Libby, MT project	All	Permanent	3/12/2003	4/10/2003		R. Mahoney/ EMSL	All data reports	No Bias	Final
LB-000021	TEM EPA 600	Gravimetric reductions (ashing and acid washing procedures) were not performed on 20 soil samples submitted by COC #D0049 & D0050 (Hygeia Job No. 22887030001), and COC #D0074 (Hygeia Job No. 22887030005)	All	Temporary: 1/2/03-1/10/03 and 1/22/03-1/24/03	1/29/2003	1/2/03-1/10/03 and 1/22/03-1/24/03		K. Corbin/ Hygeia	Hygiea reports: 22887030001 and 22887030005	No Bias	Final
LB-000022	SRC-LIBBY-03 Rev. 0	Use of only 0.2% and 1.2% Libby amphibole bulk standards in tan soil for quantification comparison in conjunction with SOP SRC-Libby-03 Rev. 0.	All	Temporary: From 16 December 2002 until bulk and permanent mount prepared slides of 0.2% and 1.0% Libby amphibole in both brown and tan soils are supplied to the involved laboratories by USGS, Denver.	3/11/2003	From 12/16/2002 to (see Duration)		R. Mahoney/ EMSL	All data reports	No Bias	Final
LB-000023	TEM-AHERA, TEM-ISO 10312	Hygeia recorded all "ND" data as "NSD" for TEM-AHERA and TEM-ISO 10312 air sample analyses.	All	Temporary	1/14/2003	6/1/02 - 11/30/02		K. Corbin/ Hygeia	22887020002 to 22887020063 excluding PLM and PCM data batch	No Bias	Final
LB-000024	PLM-NIOSH 9002	In addition to the traditional asbestos minerals, those comprising the Libby Amphibole complex will also be considered applicable analytes. Samples of 0.2 % and 1.2 % by weight Libby amphibole bulk reference materials in tan soil, prepared by the USGS, Denver, are used as comparison materials for quantification. Results will be categorized into four bins: "A" None Detected, "B1" asbestos detected but determined to be < or = 0.2%, "B2" asbestos detected but determined to be > 0.2% and < or = 1.0 %, and "C" > 1.0 %. Results will be reported as "A" – None Detected, "B1" – Trace, "B2" - < 1.0 %, and "C" – will be reported as a whole number percent.	All	Permanent	13-Mar-03	16-Dec-02		R. Mahoney/ EMSL	PLM NIOSH 9002 samples	No Bias	Final
LB-000024a	SRC-Libby-03 (Revision 1)	In addition to the traditional asbestos minerals, those comprising the Libby Amphibole complex will also be considered applicable analytes. As of December 16, 2002 samples of 0.2 % and 1.2 % by weight Libby amphibole bulk reference materials, prepared by the USGS, Denver (for use during ISTM2), are used as comparison materials for quantification of soil samples. Also, results will be categorized into four bins: "A" None Detected, "B1" asbestos detected but determined to be < 0.2%, "B2" asbestos detected but determined to be > or = to 0.2% and <1.0 %, and "C" = or > 1.0 %. Results will be reported as "A" – None Detected, "B1" – Trace, "B2" - < 1.0 %, and "C" – will be reported as a whole number percent.	All	Permanent	10-Dec-03	16-Dec-02		R.K. Mahoney/ EMSL	All PLM-VE samples	No Bias	Final
LB-000025	PCM-NIOSH 7400	For a very limited number of samples, extremely long fibers that crossed the graticle periphery twice were included in the structure enumeration.	EMSL-Libby, MT	Temporary	13-May-03	9/17/02-5/2/03		R. Mahoney/ EMSL	< 20 samples (estimated)	High Bias	Final
LB-000026	EPA/600/R-94/134 (TEM Water Method 100.2)	Only asbestos structures (including Libby Amphiboles) > 10 µm in length and 3:1 aspect ratio were counted. These samples were analyzed prior to the LB-000020.	EMSL		4-Jun-03	15-Aug-01		R. Mahoney/ EMSL	040113160 (EPA sample numbers 1R-05337, 1R-05339, 1R-06024, 1R-06026, and 1R-06027)	Low Bias	Final

TABLE 4-2. SUMMARY OF LABORATORY MODIFICATIONS

Modification No.	Method	Description of Modification	Laboratory Applicability	Duration	Date Issued	Effective Date	Date Superceded	Prepared by:	Applicable to:	Data Quality Indicator	Status
LB-000027	TEM Water EPA/600/R-94/134	Clarification of the data enumeration, recording, and reporting formats for EPA/600/R-94/134 (TEM Water Method 100.2) as they relate to the to this project.	RESI		28-May-03	(Start of Libby Project) 12/99-4/10/00		J. Orr/Reservoirs	Regarding RES Job #68278 (Samples 1-01224, 1-01225, and 1-01226)	No Bias	Final
LB-000028	All TEM Methodologies	Clarification to provide more complete TEM re-analysis data such as when some of the originally read grid openings in a sample selected for re-analysis have become unreadable	All	Permanent	17-Jun-03	17-Jun-03		R. Mahoney/ EMSL	All TEM samples	No Bias	Final
LB-000029	TEM-AHERA TEM-ISO 10312 EPA/600/R-94/134	Permanent clarifications of laboratory-based Quality Control (QC) sample analysis. The purpose is to standardize the frequency of analysis and procedures for interpretation of the results for laboratory-based QC samples for TEM analyses (all media).	All	Permanent	16-Jul-03	26-Aug-03		W.J. Brattin/ Syracuse Research Corporation	All TEM QC samples	No Bias	Final
LB-000029a	TEM-AHERA TEM-ISO 10312 ASTM D5755-95 SOP EPA-LIBBY-03 SOP EPA-LIBBY-07 EPA/600/R-94/134 (EPA 100.2)	Permanent clarifications to laboratory-based Quality Control (QC) sample analysis. The purpose of the attached is to standardize the frequency of analysis and procedures for interpretation of the results for laboratory-based Quality Control (QC) samples for TEM analyses (all media).	All	Permanent	18-Nov-03	19-Nov-03		W.J. Brattin/ Syracuse Research Corporation	All TEM Samples	Not Applicable	Final
LB-000029b	TEM-AHERA TEM-ISO 10312 ASTM D5755-95 SOP EPA-LIBBY-03 SOP EPA-LIBBY-07 EPA/600/R-94/134 (EPA 100.2)	Permanent clarifications of laboratory-based Quality Control (QC) sample analysis. The purpose is to standardize the frequency of analysis and procedures for interpretation of the results for laboratory-based QC samples for TEM analyses (all media).	All	Permanent	7-Dec-06			L. Woodbury / Syracuse Research Corporation	All TEM QC samples	Not Applicable	Final
LB-000029bx	TEM-AHERA TEM-ISO 10312 ASTM D5755	Did not follow re-preparation (RP) QC selection procedures as stated in the LB-000029b, Attachment 1 from April 2007 through present. Selected RP QCs as nominally practiced in the laboratory in stead of following high count selection procedure stated in the LB-000029b.	Hygeia	Temporary	5/8/2008 (appends to LB-000029b)	4/07-4/08		K. Corbin / Hygeia Laboratories, Inc.	Hygeia reports	No bias	In review / received / under discussion (Jun 08)
LB-000029bx	TEM-AHERA TEM-ISO 10312 ASTM D5755	From April 2007 to present, laboratory has not followed LB-000029b, Attachment 1, Paragraph 2. Specifically, the method of choosing repreparations and recounts was not followed	EMSL	Permanent	5/6/2008 (appends to LB-000029b)	6-May-08		C. LaCerra / EMSL	EMSL reports	Not Applicable	In review / received / under discussion (Jun 08)
LB-000029bx	TEM-AHERA TEM-ISO 10312 ASTM D5755	Started re-preparation (RP) QC selection procedures as stated in the LB-000029b since May 2006. Selection of RP QCs before May 2006 was based on nominal practice in the laboratory in stead of following high count selection procedure stated in the LB-000029b	Batta	Temporary/Permanent	5/27/2008 (appends to LB-000029b)	Historic - Current		B. Li / Batta	Batta reports	No Bias	In review / received / under discussion (Jun 08)
LB-000029bx	TEM-AHERA TEM-ISO 10312 ASTM D5755	When the QC sample rotation requires a reprep sample, the laboratory will select a high count sample whenever possible from the set after the initial analysis as required in LB-000029b. When filtering blanks, the laboratory will deposit 100ml particle-free water	Reservoirs	Temporary/Permanent	5/6/2008 (appends to LB-000029b)	29-Apr-08		J. Orr/Reservoirs	Reservoirs reports	No Bias	In review / received / under discussion (Jun 08)
LB-000029bx	TEM-ISO 10312 ASTM D5755	Selected re-preps based on a random selection when samples were being prepped initially. Recounts same and different were performed on the entire sample with some structures rather than the 10 GOs with the most structures	MAS	Permanent	5/13/2008 (appends to LB-000029b)	1-May-08		M. Mount / MAS	MAS reports	No Bias	In review / received / under discussion (Jun 08)
LB-000030	TEM-AHERA TEM-ISO 10312 ASTM D5755-96 EPA/600/R-94/134 (EPA 100.2)	All samples analyzed by TEM shall include sketches of all asbestos structures observed, up to a maximum of 50 structures in a sample. These sketches need not be highly detailed, but should include an indication of structure appearance, morphology, and orientation relative to any nearby landmarks, if present.	All	Permanent	5-Aug-03	14-Aug-03		W.J. Brattin/ Syracuse Research Corporation	All TEM samples	Not Applicable	Final
LB-000031	TEM-AHERA ASTM D5755-95	This clarification is intended to provide a basis for more consistent and uniform TEM results for the laboratories involved in the EPA Region 8, Libby, MT project.	All	Permanent	15-Sep-03	Historic	see LB-000031a	R. Mahoney / EMSL	All TEM samples	No Bias	Final
LB-000031a	TEM-AHERA ASTM D5755	Permanent modifications and clarifications to the Transmission Electron Microscopy analysis of air samples using AHERA and dust samples using ASTM. The purpose of the attached is to document historic modifications & clarifications, and provide additional permanent clarifications	All	Permanent	18-Jan-08	Historic		L. Woodbury / SRC	All TEM samples	Low and High Bias	Waiting for signatures (Apr 08)
LB-000031b	TEM-AHERA ASTM D5755	Laboratory-specific clarification of potential inconsistencies among analysts when recording structures using AHERA/ASTM, as modified by LB-000017, LB-000017A, and LB-000031	Batta	Permanent	9/26/2006 (appends to LB-000031a)	Historic		B. Li / Batta	Batta reports	Low and High Bias	Waiting for signatures (Apr 08)

TABLE 4-2. SUMMARY OF LABORATORY MODIFICATIONS

Modification No.	Method	Description of Modification	Laboratory Applicability	Duration	Date Issued	Effective Date	Date Superceded	Prepared by:	Applicable to:	Data Quality Indicator	Status
LB-000031c	TEM-AHERA ASTM D5755	Laboratory-specific clarification of potential inconsistencies among analysts when recording structures using AHERA/ASTM, as modified by LB-000017, LB-000017A, and LB-000031	EMSL	Permanent	9/26/2006 (appends to LB-000031a)	Historic		E. Cahill / EMSL	EMSL reports: project start date to LB-000031 effective date	No Bias	Waiting for signatures (Apr 08)
LB-000031d	TEM-AHERA ASTM D5755	Laboratory-specific clarification of potential inconsistencies among analysts when recording structures using AHERA/ASTM, as modified by LB-000017, LB-000017A, and LB-000031	Hygeia	Permanent	9/20/2006 (appends to LB-000031a)	Historic		K. Corbin / Hygeia Laboratories, Inc.	All TEM samples	??	Waiting for signatures (Apr 08)
LB-000031e	TEM-AHERA ASTM D5755	Laboratory-specific clarification of potential inconsistencies among analysts when recording structures using AHERA/ASTM, as modified by LB-000017, LB-000017A, and LB-000031	MAS	Permanent	9/25/2006 (appends to LB-000031a)	Historic		M. Mount / MAS	MAS reports	No Bias	Waiting for signatures (Apr 08)
LB-000031f	TEM-AHERA ASTM D5755	Laboratory-specific clarification of potential inconsistencies among analysts when recording structures using AHERA/ASTM, as modified by LB-000017, LB-000017A, and LB-000031	Reservoirs	Permanent	9/25/2006 (appends to LB-000031a)	Historic		J. Orr/Reservoirs	Reservoirs reports	No Bias	Waiting for signatures (Apr 08)
LB-000032	PLM-NIOSH 9002	The Reference Material columns on all PLM - VE EDDs (CDM PLM 1 through CDM PLM 82) were completed incorrectly. The actual matrix color (B or T) of the ISTM soild was used to document the macroscopial comparison. For all PLM - VE EDDs following CDM PLM 82, "ISTM" will be entered	Batta	Temporary	9-Sep-03	(From Release of Mod LB-000022) 3/11/02-9/1/03		R. Shumate / Batta Laboratories, Inc.	CDM PLM 49 through CDM PLM 80	No Bias	Final
LB-000033	PLM-SRC-LIBBY-03 (Rev. 0)	The PLM-VE Reference Material column was completed with a color (T, tan or B, brown) to indicate the standard that would be used if available to match the soil matrix color. The reference material used for the samples was the ISTM2 Reference Material as required by the current method and associated modification forms. The Project Database as populated by affected EDDs needs to be corrected to "ISTM" in the Reference Material column. This correction should be implemented based on the attached spreadsheet of affected jobs and samples.	MAS	Temporary	14-Oct-03	(March 3 - September 9, 2003)		D. Mazzaferro / MAS, Inc.		No Bias	List needs to be attached
LB-000034	PLM-SRC-LIBBY-03 (Rev. 0)	The PLM-VE Reference Material column was incorrectly completed with a color (T, tan or B, brown) to indicate the standard that would be used if available to match the soil matrix color. The reference material used for the samples was the ISTM2 Reference Material as required by the current method and associated modification forms. The Project Database as populated by affected EDDs needs to be corrected to "ISTM" in the Reference Material column. This correction should be implemented based on the attached spreadsheet of affected jobs and samples.	Reservoirs	Temporary	30-Sep-03	(March 3 - September 9, 2003)		J. Orr / Reservoirs Environmental, Inc.		No Bias	List needs to be attached
LB-000035	ASTM D5755-95	For this sample delivery group, enumeration of chrysotile was halted with the completion of the grid opening containing the 50th chrysotile structure. Analysis continued to the satisfaction of stopping rules, enumerating only Libby amphiboles	EMSL	Temporary	22-Sep-03	27-Aug-03		R. Mahoney	Job specific report	No Bias	Final
LB-000036	ASTM D5755-95	For this sample delivery group, analysis of chrysotile structure was halted with the completion of the gird opening containing the 50th chrysotile asbestos structure. Analysis continued for Libby amphiboles to achieve the desired analytical sensitivity of 1000 s/cm2.	Hygeia	Temporary	28-Oct-03	10/6/03-10/20/03		K. Corbin / Hygeia Laboratories, Inc.	Job Specific (EPA COC L6908)	No Bias for LA; Estimate for Chrysotile	Final
LB-000037	PCM-NIOSH 7400 ASTM D5755-95	Blanks CS-12613, CS-12615 and CS12617 were analyzed by PCM. They were archive blanks and should not have been analyzed. CS-12616 was analyzed by PCM instead of ASTM D5755 as requested on the chain of custody.	Reservoirs	Temporary	2/9/2004	(August 8 - September 8, 2003)		J. Orr / Reservoirs Environmental, Inc.	Job Specific (RES 96347, CoC# L6432)	No Bias	Signed original not received
LB-000038	TEM-AHERA	Samples loaded with chrysotile. Termination of enumeration of excessive numbers of chrysotile structures upon completion of the grid opening containing the 100th chrysotile structure. Enumeration of LA only will continue through the number of grid openings needed to reach stopping rules. Grid openings in which chrysotile is not enumerated will be designated by an "*" following the grid opening designation	EMSL	Temporary	4/--/2004	3/19/04-5/2/04		R. Mahoney / EMSL	Job Specific (EMSL 270400134)	No Bias	Final

TABLE 4-2. SUMMARY OF LABORATORY MODIFICATIONS

Modification No.	Method	Description of Modification	Laboratory Applicability	Duration	Date Issued	Effective Date	Date Superceded	Prepared by:	Applicable to:	Data Quality Indicator	Status
LB-000039	TEM-AHERA	The Purpose of this modification is to modify the counting rules for TEM analysis as they pertain to the presence of abundant chrysotile. Note, this modification replaces modifications LB-0000016 and LB-000017A as they Pertain to TEM-ISO 10312 TEM-AHERA clarifications associated with abundant chrysotile.	EMSL	Permanent	5/10/2004	3/24/2004		R. Mahoney / EMSL	Job specific report	No Bias	Final
LB-000040	ASTM D5755-95	Update method use from ASTM 5755-95 to ASTM 5755-93	SRC	Permanent		11/23/2005		L Woodbury / SRC	All data reports		Final
LB-000041	ASTM D5755-95	Target analytical sensitivity of 1000 s/cm^2 was not reached for Sample 1D-02233.	Hygeia	Temporary	10/27/2004	10/25/2004		K. Corbin / Hygeia Laboratories, Inc.	Job specific report (22887040082, COC #L8128)	No Bias	Final
LB-000042	ASTM D5755-95	Sensitivity on microvac sample	Reservoirs	Temporary	11/30/2004	10/20/2004			Job specific report	Estimate for Chrysotile, no bias for Libby Amphibole	in review
LB-000043	ASTM D5755-95	Analytical Sensitivity of 1000 str/cm2 not reached on Microvac sample 1D-02260	MAS	Temporary	1/3/2005	11/11/2004		D. Mazzaferro / MAS, Inc.	Job specific report (M34457-003, COC #L8145))		Final
LB-000044	ASTM D5755-95	Analytical Sensitivity not reached on Sample CS-15348	EMSL	Permanent	7/25/2006	7/21/2006		R. Mahoney / EMSL	Sample specific report (#270600693)		In review
LB-000045	TEM	Re: SQAPP	All	Permanent	6/22/2005	6/24/2005		M. Goldade	??		Refer to SQAPP, Appendix E. Placeholder LB to be created.
LB-000046	SRC-Libby-07 (Rev. 0)	Dustfall Sample SOP updates to equipment, method summary, and sample filtration.	All	Permanent	8/4/2005	6/21/05		J. Orr / Reservoirs Environmental, Inc. & K. Corbin / Hygeia Laboratories, Inc. & R. Mahoney / EMSL	All dust fall samples	No Bias	Final
LB-000047	SRC-Libby-05 Rev. 3a	Target analytical sensitivity of 1000 s/cm^2 for analysis of 20 GO's after ashing was not reached. Analytical sensitivities ranged from >6600 s/cm^2 (Samples CS-15265 and CS-15266) to >13,000 s/cm^2 (Samples CS-15106 through CS-15111 and CS-15264).	EMSL	Temporary	7/18/2005	7/12/05-7/18/05		R. Mahoney / EMSL	Job specific report (Job # 040512700)	No Bias	Final
LB-000048	ASTM D5755-95	Target analytical sensitivity of 1000 s/cm^2 was not reached for Samples CS-15356, CS-15358, CS-15449, CS-15129, CS-15130, and CS-15511.	Hygeia	Temporary	11/3/2005	8/6/05-11/3/05		K. Corbin / Hygeia Laboratories, Inc.	Job specific report (#22887050022 and 22887050023)	No Bias	In review / received 11/4/06
LB-000049	SRC-Dust-01	Recorded weight of dust collected. No further analysis.	Hygeia	Temporary	11/1/2005	11/10/05-11/11/05		K. Corbin / Hygeia Laboratories, Inc.	Job specific report (#22887050035)	Not Applicable	In review / received 11/14/06
LB-000050	ASTM D5755	Target analytical sensitivity on ashed microvac sample (CS-16065) was not reached.	EMSL	Temporary	8/25/2006	8/4/2006		R. Mahoney / EMSL	Sample specific (CS-16065) on EMSL Job No. 270600731	No Bias	Received for review on 1/5/07
LB-000051	TEM ISO 10312	Did Wayne Berman fibers apply on a specific job.	Reservoirs	Temporary	8/29/2006	12/99-2/00		J. Orr / Reservoirs Environmental, Inc.	Sample specific report		in review
LB-000052	SRC-Libby-07	Sonication of samples	Hygeia	Temporary	10/10/2006	10/5/2006		K. Corbin / Hygeia Laboratories, Inc.	Job specific report (22887060014)	No Bias	Received for review on 10/26/06
LB-000053	TEM-AHERA / TEM ISO 10312 / ASTM 5755	Relates to the project specific SOP # EPA-LIBBY-08, Indirect Preparation of Air and Dust Samples for TEM analysis. SOP provides a standardized procedure for the indirect preparation of Libby air and dust samples that minimizes the loss of sensitivity and allows for the retention of a portion of the original filter for archive whenever possible; and, indicates two general indirect preparation procedures for samples, one that includes ashing of the primary filter and one that does not include ashing of the primary filter. In addition, a reference table by sample prefix in included to indicate what method(s) should be used.	All	Permanent	10/16/2006	12-Dec-06		M. Raney / Volpe		Not Applicable	Final
LB-000054	TEM ISO 10312	Bacterial growth observed on settled dust samples (DM-xxxxx samples on COCs L11265, L11303, and L11342).	Hygeia	Temporary	10/16/2006	10/5/06-10/25/06		K. Corbin / Hygeia Laboratories, Inc.	Job specific reports (#22887060014 through 22887060016)	Low Bias	Received for review on 10/26/06

TABLE 4-2. SUMMARY OF LABORATORY MODIFICATIONS

Modification No.	Method	Description of Modification	Laboratory Applicability	Duration	Date Issued	Effective Date	Date Superceded	Prepared by:	Applicable to:	Data Quality Indicator	Status
LB-000055	TEM ISO 10312	This laboratory modification relates to samples taken in accord with the Outdoor Ambient Air Monitoring Program in Libby, Montana and that are to be analyzed by the ISO 10312 TEM method. Due to inherent meteorological conditions prevalent in Libby starting in late October 2006 (fog, inversions, other potential precipitation), the samples arrive at the laboratory in a damp condition. To enable the samples to be properly prepared and to prevent subsequent biological growth, all samples will be dried upon receipt that the onsite laboratory (EMSL-Libby), prior to further preparation/analysis at the onsite laboratory or prior to transmittal to another laboratory for further preparation/analysis	EMSL	Permanent	10/31/2006	10/31/2006		R. Mahoney / EMSL		No Bias	In review / Rev 1 received 11/2/06
LB-000056	TEM ISO 10312	Pre-approval of LB-000055, a Drying Oven Blank was included with each batch of air samples (total of 4) collected as part of the Outdoor Ambient Air Monitoring Program in Libby, Montana and delivered to EMSL Analytical in Libby, MT between October 20 and 23, 2006. The air samples arrived at the laboratory in a damp condition due to inherent meteorological conditions (fog, inversions, and other precipitation) during sample collection. The samples were all placed in a single drying oven to dry on 27 October 2006.	EMSL	Temporary	11/2/2006	10/27/2006		R. Mahoney / EMSL	Specific COCs (L11413, L11414, L11419, and L11420); Drying Oven Blanks were recorded on COCs: L11454, L11455, L11459, and L11460.	No Bias	Received for review on 11/2/06
LB-000057	TEM ISO 10312	Ambient air sample AA-00102 was analyzed via direct procedure when loading was estimated ~ 35%. Sample analysis is voided.	MAS	Permanent	12/5/2006	12/5/2006		M. Mount / MAS	Sample specific on COC L11445	Low Bias	Received for review on 12/12/06
LB-000058	ASTM D5755	During sample preparation, the sample filter was ashed and then double diluted. Resolution made to address the intent of SOP EPA-Libby-08 was to re-combine the prepped sample filters for each sample, ash them, and then perform a serial dilution on each sample	EMSL-Libby, MT	Temporary/Permanent	1/5/2007	12/13/06 / 1/4/07		R. Mahoney / EMSL	Specific COC: L11507 (270601291)	No Bias	Received for review on 2/6/07
LB-000059	TEM ISO 10312	Some of the original filters exhibited uneven distribution and were ashed and suspended in 100 ml of particle free water. The entire 100 ml was filtered through a secondary filter. These filters were then directly prepared for TEM analysis	EMSL-Libby, MT	Temporary	1/5/2007	12/26-27/06		R. Mahoney / EMSL	Specific COCs: L11521 (270601304) and L11523 (270601307)	No Bias	Received for review on 2/6/07
LB-000060	TEM ISO 10312	The direct preparation of a sample was only slightly overloaded. It was decided that ashing one half of the filter, suspending it in 100 ml of particle free water and depositing it all on a secondary filter would yield a sample conforming to project overload criteria	EMSL-Libby, MT	Temporary	1/5/2007	12/29/2009		R. Mahoney / EMSL	Sample specific (AA-00012) on COC L11525 (EMSL Job No. 270601311)	No Bias	Received for review on 2/6/07
LB-000061	TEM 5755	Samples exhibited heavy particulate loading and the initial filtration was overloaded. A serial dilution was prepared and aliquots were filtered in accordance with the established SOP procedures. The remaining portion of the original solution was filtered and archived.	EMSL-Libby, MT	Temporary	1/11/2007	12/2006-2/2007		R. Mahoney / EMSL	Specific COCs: L11527, L11533, L11542, L11545, and L11549 (EMSL Job Nos. 270601309, 270700003, 270700012, 270700015, and 270700018)	No Bias	Received for review on 2/8/07
LB-000062	PLM	Screening	EMSL-Libby, MT	Temporary		8/6-8/17/2001		R. Mahoney / EMSL			Received for review on 2/13/07
LB-000063	TEM ISO 10312	Sample preparation procedure used on composited snow samples.	EMSL-Libby, MT	Temporary	2/6/2007	1/25/2007		R. Mahoney / EMSL	Specific COC: L11571 (EMSL Job No. 270700032)	No Bias	Received for review on 2/6/07
LB-000064	ASTM D5755 / SRC-Libby-05	Target analytical sensitivity on Sample CS-14744 was not reached. Triple dilution required during sample preparation.	EMSL-Libby, MT	Temporary	2/6/2007	2/5/2007		R. Mahoney / EMSL	Specific COC: L11583 (EMSL Job No. 270700040)	Low Bias ?	Received for review on 2/6/07
LB-000065	ASTM D5755	Analytical sensitivity can not be achieved.	EMSL-Westmont, NJ	Temporary	2/15/2007	2/9/2007		R. Mahoney / EMSL	Specific COC: L11557 (EMSL Job No. 040701394)	No Bias	Received for review on 3/21/07
LB-000066	TEM-AHERA / TEM ISO 10312 / ASTM 5755	Change to LA counting rules: presence of sodium and potassium peaks to be recorded; close call NAMs to be recorded; increase frequency of EDS spectra	All	Temporary	2/15/2007	2/27/07 - until notified		B. Brattin / SRC	All investigative samples	Not Applicable	Final

TABLE 4-2. SUMMARY OF LABORATORY MODIFICATIONS

Modification No.	Method	Description of Modification	Laboratory Applicability	Duration	Date Issued	Effective Date	Date Superceded	Prepared by:	Applicable to:	Data Quality Indicator	Status
LB-000066a	TEM-AHERA / TEM ISO 10312 / ASTM 5755	Change to LA counting rules: presence of sodium and potassium peaks to be recorded; close call NAMs to be recorded; increase frequency of EDS spectra; increase frequency of photographic images of particle morphology	All	Temporary	3/13/2007	3/14/07 - until notified	*4/12/2007*	B. Brattin / SRC	All investigative samples	Not Applicable	Final
LB-000066b	TEM-AHERA / TEM ISO 10312 / ASTM 5755	Change to LA counting rules: presence of sodium and potassium peaks to be recorded; close call NAMs to be recorded; increase frequency of EDS spectra; increase frequency of photographic images of particle morphology; and utilize comment field to record mineral type.	All	Temporary	4/12/2007	4/12/2007 - until notified	*9/12/2007*	B. Brattin / SRC	All investigative samples	Not Applicable	Final
LB-000066c	TEM-AHERA / TEM ISO 10312 / ASTM 5755	Change to LA counting rules: presence of sodium and potassium peaks to be recorded; close call NAMs to be recorded; frequency of EDS spectra; frequency of photographic images of particle morphology; and utilize comment field to record mineral type.	All	Temporary	9/11/2007	9/12/2007 - until notified	7/20/2010	B. Brattin / SRC	All investigative samples	Not Applicable	Final
LB-000066d	TEM-AHERA / TEM ISO 10312 / ASTM 5755	Change to LA counting rules: presence of sodium and potassium peaks to be recorded; close call NAMs to be recorded; increase frequency of EDS spectra; increase frequency of photographic images of particle morphology; and utilize comment field to record mineral type.	All	Permanent	9/11/2007	7/20/2010		R. Mahoney / EMSL	All investigative samples	No Bias	Final
LB-000067	TEM-AHERA / ASTM 5755	Standardize use of bench forms between all laboratories and additional information on the basis of fiber classification using morphology, diffraction pattern and energy dispersive x-ray spectrum.	All	Permanent	5/16/2007	12/12/2007		M. Mount / MAS		No Bias	Received for review on 6/12/07
LB-000068	TEM ISO 10312	Identify the settled dust samples that contained abundant bacteria growth.	MAS	Temporary	9/11/2007	8/30/07-9/10/07		M. Mount / MAS	Job specific reports: MAS Project #'s M44470 (L12775), M44471 (L12774), M44486 (L12787), M44487 (L12786), M44586 (L12827), M44587 (L12829), M44506 (L12797), M44507 (L12798), M44604 (L12839), and M44605 (L12840)	No Bias	Received for review on 12/3/07
LB-000069	TEM ISO 10312	Analysis will be terminated after the analysis of 100 grid openings (0.013 mm2 each) instead of continuing to the requested analytical sensitivity of 0.001 s/cc	EMSL-Libby, MT	Temporary	10/18/2007	10/18/2007		R. Mahoney/ EMSL	Job specific: 270700963	No Bias	Received for review on 11/7/07
LB-000070	TEM ISO 10312	Counting Rules were modified to stop counting chrysotile structures at the end of the grid opening containing the 50th chrysotile structure. Analysis was continued for LA structures to the desired sensitivity or 100 grid openings.	All	Permanent		10/1/2007		R. Mahoney/ EMSL		No Bias	Received for review on 11/27/07
LB-000071	TEM ISO 10312	Samples were prepared by direct preparation that were requested by indirect dust preparation due to laboratory error. Samples were reported in the EDD with indirect preparation with a dilution factor of "1".	Reservoirs	Temporary	2/12/2008	8/6/07-8/10/07		J. Orr / Reservoirs	Job specific: RES 142640 (L12528)	No Bias	in review (5/8/08)
LB-000072	PLM-Grav	To document practice when a trace level (below that which can be quantified) is detected, the sample is generally reported as ND with a note in the comment field that a trace level was detected in the fine fraction of the coarse sample. SRC suggests that this sample should be recorded as TR (trace) rather than ND. Modification is intended to document the issue and the date at which any change in practice was implemented.	Reservoirs	Permanent	1/10/2008	12/17/2007		J. Orr / Reservoirs		No Bias	Received for review on 1/29/08
LB-000073	SRC-LIBBY-03	Permanent clarifications to laboratory-based Quality Control (QC) sample analysis for PLM-VE analyses. The purpose is to standardize the selection and analysis procedures for interlaboratory samples of soil.	All	Permanent	11/20/2007	11/20/2007		L. Woodbury / SRC		Not Applicable	Final
LB-000074	TEM ISO 10312	EP samples - overall to have 100 grid opening stopping rule	All	Temporary	11/27/2007	11/20/2007		R. Mahoney/ EMSL		No Bias	Received for review on 12/4/07
LB-000075	TEM ISO 10312	For all DM samples: change in counting rules from $\geq$3:1 to $\geq$5:1	All	Permanent	12/11/2007	1/1/2008		L. Woodbury / SRC			in review

TABLE 4-2. SUMMARY OF LABORATORY MODIFICATIONS

Modification No.	Method	Description of Modification	Laboratory Applicability	Duration	Date Issued	Effective Date	Date Superceded	Prepared by:	Applicable to:	Data Quality Indicator	Status
LB-000076	TEM ISO 10312	Specified analytical sensitivity will not be reached. 100 grid opening stopping rule applied to these OU5 samples.	All	Temporary	11/27/2007	11/12/2007		R. Mahoney/ EMSL	Job specific: EMSL 270701088 (L13120)		Received for review on 11/27/07
LB-000077	TEM ISO 10312	ABS Field Blanks - 30 grid opening stopping rule for all air and dust samples	All	Permanent	11/27/2007	10/30/2007		J. Orr / Reservoirs		No Bias	Final
LB-000078	TEM ISO 10312 ASTM 5755	ABS (exterior) samples - overall to have 100 grid opening stopping rule	All	Permanent	11/27/2007	8/16/2007		J. Orr / Reservoirs & W. Brattin / SRC		No Bias	Final
LB-000079	TEM ISO 10312 ASTM 5755	ABS (interior) samples - overall to have 100 grid opening stopping rule	All	Permanent	11/27/2007	10/24/2007		J. Orr / Reservoirs & W. Brattin / SRC		No Bias	Final
LB-000080	TEM ISO 10312	A low volume ambient air sample and associated blank sample were ashed and indirectly prepped due to an unknown exposure prior to sample receipt.	EMSL	Temporary	1/11/2008	10/30/2007		R. Mahoney/ EMSL	Job Specific: EMSL 270701158 (L13227)	No Bias	Received 1/11/08. Volpe review completed on 2/12/08
LB-000081	TEM ISO 10312	Analyses terminated at 100 grid openings after ashing. Did not achieve target analytical sensitivity.	EMSL	Temporary	1/16/2008	11/26/2008		R. Mahoney/ EMSL	Job Specific: EMSL 040729249 (L13283)	No Bias	Received 1/16/08. Volpe review completed on 2/12/08
LB-000082	TEM ISO 10312	Analyses terminated at 100 grid openings. Did not achieve target analytical sensitivity.	Reservoirs	Temporary		7/27/07-8/12/07		J. Orr / Reservoirs	Job Specific: RES Job #142204 (L12426); RES Job #142198 (L12428); RES Job # 142209 (L12425); RES 142221 (L12628)	No Bias	Received for review on 2/12/08
LB-000083	TEM ISO 10312	Enumeration of chrysotile structures was terminated at 50 grid openings.	EMSL	Temporary	1/29/2008	11/23/2007		R. Mahoney/ EMSL	Job Specific: EMSL 040429249 (L13283)	No Bias	Received 1/31/08. Volpe review completed on 2/12/08
LB-000084	TEM-AHERA TEM-ISO 10312 ASTM D5755-95 EPA/540/2-90/005a SOP EPA-LIBBY-03 SOP EPA-LIBBY-07 EPA/600/R-94/134 (EPA 100.2)	To modify the counting rules for all TEM analysis methodologies as they pertain to the presence of abundant chrysotile. Supercedes LB-000016a and LB-000017a.	All	Permanent	1/29/2008	1/29/2008		R. Mahoney/ EMSL		No Bias	Received for review on 1/31/08
LB-000085	TEM	Laboratories conducting transmission electron microscopy (TEM) or scanning electron microscopy (SEM) analysis in support of either the Libby Site (all operable units, including Troy) or Libby Action Plan shall perform analysis of a reference standard to calibrate the energy dispersive x-ray spectrometry (EDS) analysis.	All	Permanent	3/25/2008	4/23/2008		M. Goldade / EPA		No Bias	In final review
LB-000086	PLM	All samples analyzed by SRC-Libby-03 (PLM-VE) shall be referenced by the use of a concatenation of the Index ID, Suffix ID, and the Suffix # (e.g. 1D-00827-FG2).	All	Permanent	4/22/2008	4/22/2008		R. Mahoney / EMSL		No Bias	Received for review on 1/31/08
LB-000087	TEM ISO	The low volume sample of a paired high and low volume Ambient Air sample was prepared and analyzed.	EMSL	Temporary	6/3/2008	5/28/2008		R. Mahoney/ EMSL	Job Specific: EMSL 270800320	No Bias	Received for review on 6/10/08
LB-000088	All TEM methodologies\	Clarification of grid opening area vs number of grid openings stopping rule	All	Permanent	10/28/008	TBD		A. Castelli/ Volpe		No Bias	
LB-000089	TEM ISO	ABS Sample EX-00549 to be corrected to damaged filter status from direct prep, Not QA.	EMSL	Temporary		8/28/2009		R. Mahoney/ EMSL	Job Specific:		

AHERA = Asbestos Hazard Emergency Response Act
ABS = activity-based sampling
ASTM = American Society for Testing and Materials
COC = chain of custody
EDD = electronic deliverable document
GO = grid opening
ISO = International Organization for Standardization
LA = Libby amphibole
n/a = not applicable
ND = non-detect
NIOSH = National Institute for Occupational Safety and Health
NSD = no structures detected
PLM = polarized light microscopy
PLM-VE = polarized light microscopy visual area estimation
QC = quality control
RESI = Reservoir Environmental Services, Inc.
SOP = standard operatng procedure
SQAPP = supplemental quality assurance project plan
TEM = transmission electron microscopy

TABLE 4-3. MOBILE LAB AIR AND DUST MONITORING SAMPLES

Panel A: TEM Results

Medium		Year	Number of Samples	Number of Samples with Detected LA	LA Detection Frequency	Range of Detected LA Conc Values (air - s/cc, dust s/cm^2)	
						Minimum	Maximum
Air	Personal	2002	34	11	32%	0.021	2.8
	Ambient Stationary	2002	85	1	1%	0.017	0.017
		2003	15	0	0%	--	--
		2004	47	0	0%	--	--
		2005	46	1	2%	0.004	0.004
		2006	48	2	4%	0.003	0.06
		2007	48	0	0%	--	--
		2008	44	0	0%	--	--
		2009	40	1	3%	0.003	0.003
Dust		2002	29	6	21%	36	506
		2003	14	0	0%	--	--
		2004	36	0	0%	--	--
		2005	33	0	0%	--	--
		2006	36	0	0%	--	--
		2007	20	0	0%	--	--

Panel B: PCM Results

Medium		Year	Number of Samples	Number of Detected Samples	Detection Frequency	Range of Detected Dust Concentration Values (s/cc)	
						Minimum	Maximum
Air	Personal	2002	30	18	60%	0.004	4.468
	Ambient Stationary	2002	10	10	100%	0.004	0.040
		2004	12	10	83%	0.004	0.019
		2005	4	3	75%	0.006	0.007
		2006	12	12	100%	0.002	0.038
		2007	4	3	75%	0.012	0.020
		2009	8	6	75%	0.003	0.023

Libby2DB Download: 12/8/09

conc = concentration
LA = Libby amphibole
PCM = phase contrast microscopy
s/cc =structures per cubic centimeter
s/cm^2 = structures per square centimeter
TEM = transmission electron microscopy

TABLE 5-1. VERIFICATION SUMMARY FOR THE LIBBY PROJECT

Program (Timeframe)	Source of Verification Summary	Dataset	Items Validated	Number of Analyses Validated
DOJ Exhibits (6/00-6/05)	DOJ Validation Summary Report	Screening Plant Worker Personal Air	100% TEM	1,202
		Screening Plant Stationary Air Pre 6-00	100% TEM	10
		Export Plant Stationary Air Pre 6-00	100% TEM	11
		High School Dust	All Detected by TEM	9
		Residential Dust	All Detected by TEM	18
		Westfall Personal Air	All Detected by TEM	4
		RCR Stationary Air	All Detected by TEM	163
		RCR Personal Air	All Detected by TEM	124
		Worker Personal Air Samples from Properties of Interest	10% PCM[a]	205
		Soil from Properties of Interest	All Detected by PLM-9002	606
			All Detected by PLM-VE	52
		GIS Component Soil Samples	5% of detected, followed 15% of samples by PLM-9002, PLM-VE	9002 = 242
				VE = 278
Indirect-Direct (5/01-6/05)	Direct-Indirect Pilot Study TEM Review Report	First Round Pilot Study	100% TEM	62
Demolition (6/05-10/06)	Demolition Summary Report	Stationary Air	100% TEM/FSDS	179
SQAPP (6/05 - 10/06)	No Report	Task 6-9	10% TEM	43
		Re-analysis	10% TEM	55
		Initial 10%	10% TEM	39
		All RESI Samples	100% TEM	28
		Task 2 Dust	10% TEM	17
		All Samples	10% FSDS	50
Ambient Air (10/06 - 6/08)	Ambient Air Summary Report	Stationary Air	100% Events 1-17, 10% remaining events TEM/FSDS	279
OU4 ABS (5/07 - 6/08)	ABS Summary Report	Personal Air	100% TEM/FSDS	1,427
		Soil	100% PLM-VE/FSDS	387
OU5 (10/07-10/08)	Draft RI or separate report	Personal Air	10% TEM/FSDS	42
		Soil	10% PLM	108
Schools-Indoor (12/08)	Schools Report	Stationary Air	100% TEM/FSDS	50
Schools-Outdoor (7/09-9/09)	Schools Report	Personal Air	10% TEM/FSDS	7
		Soil	10% PLM/FSDS	5

[a] 10% of the lab jobs were selected. From this list, at least 10% of the total samples were selected. Samples which included "*long shed*" in the sample comments or location description were also selected.

DOJ = Department of Justice
FSDS = field sample data sheet
GIS = geographic information system
PCM = phase contrast microscopy
PLM = polarized light microscopy
PLM-VE = polarized light microscopy visual area estimation
RCR = Raint Creek Road
RESI = Reservoirs Environmental Services, Inc.
RI = remedial investigation
SQAPP = supplimental quality assurance project plan
TEM = transmission electron microscopy

TABLE 6-1. TEM LOT BLANK SUMMARY

Panel A: Lot Blank Collection Frequency by Year

Year	Number of TEM Analyses for Air and Dust Samples		Lot Blank Analysis Frequency
	Lot Blanks	Field Samples	
1999	9	127	7.1%
2000	9	3,116	0.3%
2001	20	9,173	0.2%
2002	8	4,213	0.2%
2003	185	6,523	2.8%
2004	89	3,044	2.9%
2005	129	3,933	3.3%
2006	139	3,688	3.8%
2007	95	3,766	2.5%
2008	17	2,959	0.6%
2009	7	1,518	0.5%
1999-2009	707	42,060	1.7%

Panel B: Lot Blank TEM Results

Preparation Method	Number of Analyses	Asbestos Detection Frequency	Total Area Examined (mm^2)	Total Asbestos Structures Observed
Direct	694	0%	88.1	0
Indirect	13	0%	0.9	0
All	707	0%	89.0	0

Libby2DB Download: 12/8/09

mm^2 = square millimeters
TEM = transmission electron microscopy

TABLE 6-2. PCM LOT BLANK SUMMARY

Panel A: PCM Lot Blank Collection Frequency

Year	Number of Samples		Lot Blank Collection Frequency
	Lot Blanks	Field Samples	
1999	0	0	NA
2000	0	1,937	0%
2001	9	5,605	0.2%
2002	4	1,205	0.3%
2003	142	922	15%
2004	69	1,012	6.8%
2005	80	758	10.6%
2006	83	973	8.5%
2007	70	1,146	6.1%
2008	11	1,249	0.9%
2009	5	731	0.7%
1999-2009	473	15,538	3.0%

Panel B: PCM Lot Blank Results

Prep Method	N Analyses	N Detects (%)	Observed Loading (f/mm^2)		
			Mean	Minimum	Maximum
Direct	473	22 (4.7%)	0.29	0	5.7

Libby2DB Download: 12/8/2009

PCM = phase contrast microscopy

NIOSH = National Institute for Occupational Safety and Health

N = number

NA = not applicable because PCM field samples were not collected this year.

f/mm^2 = fibers per square millimeter

TABLE 6-3. TEM FIELD BLANK SUMMARY

Panel A: Field Blank Analysis Frequency by Year

Year	N TEM Analyses for Air and Dust Samples		Field Blank Analysis Frequency
	Field Blanks	Field Samples	
1999	11	127	9%
2000	509	3,116	16%
2001	1,516	9,173	17%
2002	781	4,213	19%
2003	819	6,523	13%
2004	514	3,044	17%
2005	614	3,933	16%
2006	513	3,688	14%
2007	508	3,766	13%
2008	368	2,959	12%
2009	234	1,518	15%
1999-2009	6,387	42,060	15%

Panel B: Field Blank TEM Results

Preparation Method	N Analyses	LA Detection Frequency	Total Area Examined (mm^2)	N Total LA Structures Observed	Total LA Loading Rate (s/mm^2)
Direct	5,383	3 (0.06%)	714	5	0.007
Indirect or Indirect-Ashed	1,004	5 (0.5%)	123	7	0.06
All	6,387	8 (0.1%)	837	12	0.014

Libby2DB Download: 12/8/09

LA = Libby amphibole

mm^2 = square millimeters

N = number

TEM = transmission electron microscopy

TABLE 6-4. PCM FIELD BLANK SUMMARY

Panel A: PCM Field Blank Collection Frequency

Year	Number of PCM Samples		Field Blank Collection Frequency
	Field Blanks	Field Samples	
1999	0	0	NA
2000	491	1,937	25%
2001	868	5,605	15%
2002	352	1,205	29%
2003	165	922	18%
2004	140	1,012	14%
2005	42	758	6%
2006	37	973	4%
2007	28	1,146	2%
2008	18	1,249	1%
2009	20	731	3%
1999-2009	2,161	15,538	14%

Panel B: PCM Field Blank Results

Preparation Method	N Analyses	N Analyses > NIOSH 7400 Bkg Loading Rate	Total Number of Fibers Observed	Observed Loading (f/mm^2)		
				Mean	Minimum	Maximum
Direct	2,150	25 (1.2%)	830.5	0.55	0	247
Indirect	11	0	0	0	0	0
All	2,161	25 (1.2%)	830.5	0.54	0	247

Panel C: PCM Field Blank Results (5 suspect samples excluded)

Preparation Method	N Analyses	N Analyses > NIOSH 7400 Bkg Loading Rate	Total Number of Fibers Observed	Observed Loading (f/mm^2)		
				Mean	Minimum	Maximum
Direct	2,145	20 (0.93%)	483.5	0.29	0	14
Indirect	11	0	0	0	0	0
All	2,156	20 (0.93%)	483.5	0.29	0	14

Libby2DB Download Date: 12/8/09

f/mm^2 = fibers per square millimeter
N = number
NA = Not applicable because PCM field samples were not collected in this year.
NIOSH = National Institute for Occupational Safety and Health
PCM = phase contrast microscopy

TABLE 6-5. TEM FIELD DUPLICATE SUMMARY

Panel A: Air Field Duplicates

Sampling Program	Original Result				Field Duplicate Result				Poisson Rate Comparison (90% CI)
	Index ID	Number LA Structures	Sensitivity (1/cc)	Total LA Conc (s/cc)	Index ID	Number LA Structures	Sensitivity (1/cc)	Total LA Conc (s/cc)	
INDOOR AIR									
Phase 1	1-01572	6	1.4E-03	8.4E-03	1-01573	6	1.4E-03	8.4E-03	[0.33-3.08] The rates are not different
	1-01575	0	1.4E-03	0.0E+00	1-01576	0	1.4E-03	0.0E+00	Both counts are 0; the rates are not different
Phase 2	2-00157	1	6.1E-04	6.1E-04	2-00158	0	2.5E-04	0.0E+00	[0-7.6] The rates are not different
	2-00249	**8**	**6.0E-04**	**4.8E-03**	**2-00250**	**1**	**5.1E-04**	**5.1E-04**	**[1.56-205.23] Rate 1 is greater than Rate 2**
	2-00466	0	1.3E-01	0.0E+00	2-00467	0	1.3E-01	0.0E+00	Both counts are 0; the rates are not different
	2-00478	**6**	**1.6E-02**	**9.5E-02**	**2-00479**	**0**	**1.5E-02**	**0.0E+00**	**[0-0.61] Rate 1 is greater than Rate 2**
	2-00516	0	1.0E-02	0.0E+00	2-00518	1	1.0E-02	1.0E-02	[0-19] The rates are not different
	2-00526	0	1.0E-02	0.0E+00	2-00528	0	1.0E-02	0.0E+00	Both counts are 0; the rates are not different
	2-00619	0	1.0E-02	0.0E+00	2-00622	0	1.0E-02	0.0E+00	Both counts are 0; the rates are not different
	2-00633	1	1.7E-02	1.7E-02	2-00636	0	1.6E-02	0.0E+00	[0-17.84] The rates are not different
	2-00659	0	1.2E-02	0.0E+00	2-00662	0	1.2E-02	0.0E+00	Both counts are 0; the rates are not different
	2-00669	3	9.6E-02	2.9E-01	2-00671	0	9.6E-02	0.0E+00	[0-1.71] The rates are not different
	2-00683	0	1.3E-02	0.0E+00	2-00685	0	1.3E-02	0.0E+00	Both counts are 0; the rates are not different
	2-00709	0	8.8E-03	0.0E+00	2-00711	0	8.8E-03	0.0E+00	Both counts are 0; the rates are not different
	2-00809	0	4.1E-03	0.0E+00	2-00810	0	4.1E-03	0.0E+00	Both counts are 0; the rates are not different
Cumulative	CE-00053	0	1.5E-04	0.0E+00	CE-00054	0	1.5E-04	0.0E+00	Both counts are 0; the rates are not different
Exposure	CE-00082	0	7.1E-04	0.0E+00	CE-00083	0	7.1E-04	0.0E+00	Both counts are 0; the rates are not different
Stimson Lumber	SL-00023	0	2.6E-03	0.0E+00	SL-00024	0	2.6E-03	0.0E+00	Both counts are 0; the rates are not different
	SL-00213	0	6.2E-03	0.0E+00	SL-00214	0	6.2E-03	0.0E+00	Both counts are 0; the rates are not different
	SL-00222	0	4.6E-03	0.0E+00	SL-00223	0	2.1E-03	0.0E+00	Both counts are 0; the rates are not different
SQAPP	SQ-00140	4	5.9E-05	2.4E-04	SQ-00181	9	6.1E-05	5.5E-04	[0.12-1.31] The rates are not different
OUTDOOR AIR									
Phase 1R	1R-24693	0	4.6E-03	0.0E+00	1R-24694	0	4.6E-03	0.0E+00	Both counts are 0; the rates are not different
Ambient Air	AA-00130	0	3.9E-05	0.0E+00	AA-00128	0	3.9E-05	0.0E+00	Both counts are 0; the rates are not different
	AA-00165	0	4.3E-05	0.0E+00	AA-00170	0	4.2E-05	0.0E+00	Both counts are 0; the rates are not different
	AA-00231	0	3.7E-05	0.0E+00	AA-00132	0	3.6E-05	0.0E+00	Both counts are 0; the rates are not different
	AA-00259	0	3.8E-05	0.0E+00	AA-00281	0	3.8E-05	0.0E+00	Both counts are 0; the rates are not different
	AA-00287	0	3.8E-05	0.0E+00	AA-00289	0	3.7E-05	0.0E+00	Both counts are 0; the rates are not different
	AA-00377	0	3.7E-05	0.0E+00	AA-00379	0	3.8E-05	0.0E+00	Both counts are 0; the rates are not different
	AA-00421	0	3.9E-05	0.0E+00	AA-00426	0	3.8E-05	0.0E+00	Both counts are 0; the rates are not different
	AA-00445	0	3.8E-05	0.0E+00	AA-00459	0	3.8E-05	0.0E+00	Both counts are 0; the rates are not different
	AA-00480	0	3.7E-05	0.0E+00	AA-00486	0	3.8E-05	0.0E+00	Both counts are 0; the rates are not different
	AA-00524	0	3.7E-05	0.0E+00	AA-00526	0	3.7E-05	0.0E+00	Both counts are 0; the rates are not different
	AA-00564	0	3.8E-05	0.0E+00	AA-00568	0	3.8E-05	0.0E+00	Both counts are 0; the rates are not different
	AA-00606	0	3.8E-05	0.0E+00	AA-00636	0	3.8E-05	0.0E+00	Both counts are 0; the rates are not different
	AA-00692	0	3.8E-05	0.0E+00	AA-00694	0	3.8E-05	0.0E+00	Both counts are 0; the rates are not different
	AA-00708	0	4.0E-05	0.0E+00	AA-00712	0	3.8E-05	0.0E+00	Both counts are 0; the rates are not different
	AA-00834	0	3.8E-05	0.0E+00	AA-00833	0	3.8E-05	0.0E+00	Both counts are 0; the rates are not different
	AA-00897	0	3.8E-05	0.0E+00	AA-00899	0	1.9E-05	0.0E+00	Both counts are 0; the rates are not different
	AA-00978	0	3.7E-05	0.0E+00	AA-00980	0	3.7E-05	0.0E+00	Both counts are 0; the rates are not different
	AA-01022	0	3.8E-05	0.0E+00	AA-01024	0	3.8E-05	0.0E+00	Both counts are 0; the rates are not different
	AA-01066	0	3.8E-05	0.0E+00	AA-01073	0	3.8E-05	0.0E+00	Both counts are 0; the rates are not different
	AA-01103	0	3.8E-05	0.0E+00	AA-01105	0	3.8E-05	0.0E+00	Both counts are 0; the rates are not different
	AA-01148	0	3.8E-05	0.0E+00	AA-01146	0	3.8E-05	0.0E+00	Both counts are 0; the rates are not different
	AA-01168	0	3.8E-05	0.0E+00	AA-01175	0	3.8E-05	0.0E+00	Both counts are 0; the rates are not different
	AA-01231	0	3.7E-05	0.0E+00	AA-01238	0	3.7E-05	0.0E+00	Both counts are 0; the rates are not different
	AA-01305	0	4.0E-05	0.0E+00	AA-01307	0	3.9E-05	0.0E+00	Both counts are 0; the rates are not different
	AA-01312	0	4.0E-05	0.0E+00	AA-01314	0	4.0E-05	0.0E+00	Both counts are 0; the rates are not different
	AA-01353	1	3.7E-05	3.7E-05	AA-01355	0	3.7E-05	0.0E+00	[0-19.08] The rates are not different
	AA-01449	1	3.6E-05	3.6E-05	AA-01451	0	3.6E-05	0.0E+00	[0-19] The rates are not different
	AA-01494	0	3.7E-05	0.0E+00	AA-01496	1	3.7E-05	3.7E-05	[0-18.66] The rates are not different
	AA-01533	2	3.9E-05	7.8E-05	AA-01535	0	4.0E-05	0.0E+00	[0-3.53] The rates are not different
	AA-01542	0	3.8E-05	0.0E+00	AA-01544	0	3.8E-05	0.0E+00	Both counts are 0; the rates are not different
	AA-01605	3	3.7E-05	1.1E-04	AA-01607	5	3.8E-05	1.9E-04	[0.12-2.42] The rates are not different
	AA-01657	0	3.9E-05	0.0E+00	AA-01659	3	3.9E-05	1.2E-04	[0-1.69] The rates are not different
	AA-01712	0	3.7E-05	0.0E+00	AA-01714	0	3.9E-05	0.0E+00	Both counts are 0; the rates are not different
	AA-01749	0	3.8E-05	0.0E+00	AA-01770	0	3.8E-05	0.0E+00	Both counts are 0; the rates are not different
	AA-01793	0	3.8E-05	0.0E+00	AA-01795	0	3.8E-05	0.0E+00	Both counts are 0; the rates are not different
	AA-01829	0	3.7E-05	0.0E+00	AA-01831	0	3.7E-05	0.0E+00	Both counts are 0; the rates are not different
	AA-01853	0	3.9E-05	0.0E+00	AA-01855	0	3.9E-05	0.0E+00	Both counts are 0; the rates are not different
	AA-01889	0	3.9E-05	0.0E+00	AA-01891	0	3.9E-05	0.0E+00	Both counts are 0; the rates are not different
	AA-01903	0	3.8E-05	0.0E+00	AA-01905	0	3.8E-05	0.0E+00	Both counts are 0; the rates are not different
	AA-01921	0	3.7E-05	0.0E+00	AA-01923	0	3.7E-05	0.0E+00	Both counts are 0; the rates are not different
	AA-01937	0	3.8E-05	0.0E+00	AA-01939	0	3.8E-05	0.0E+00	Both counts are 0; the rates are not different
	AA-01945	0	3.7E-05	0.0E+00	AA-01947	0	3.7E-05	0.0E+00	Both counts are 0; the rates are not different
	AA-01964	0	3.8E-05	0.0E+00	AA-01960	0	3.8E-05	0.0E+00	Both counts are 0; the rates are not different
	AA-01976	0	3.9E-05	0.0E+00	AA-01978	0	3.9E-05	0.0E+00	Both counts are 0; the rates are not different
SQAPP	SQ-00096	1	3.6E-02	3.6E-02	SQ-00097	1	3.6E-02	3.6E-02	[0.03-38.49] The rates are not different
	SQ-00336	0	9.9E-04	0.0E+00	SQ-00337	0	9.7E-04	0.0E+00	Both counts are 0; the rates are not different
	SQ-00419	0	1.1E-03	0.0E+00	SQ-00420	0	1.1E-03	0.0E+00	Both counts are 0; the rates are not different
	SQ-00458	0	9.8E-04	0.0E+00	SQ-00459	0	1.0E-03	0.0E+00	Both counts are 0; the rates are not different
	SQ-00475	0	3.3E-03	0.0E+00	SQ-00476	5	2.1E-03	1.1E-02	[0-1.26] The rates are not different
	SQ-00489	**9**	**8.6E-04**	**7.7E-03**	**SQ-00490**	**17**	**9.7E-04**	**1.7E-02**	**[0.21-0.98] Rate 1 is less than Rate 2**
	SQ-00592	0	9.9E-04	0.0E+00	SQ-00593	0	9.8E-04	0.0E+00	Both counts are 0; the rates are not different

TABLE 6-5. TEM FIELD DUPLICATE SUMMARY

Panel B: Dust Field Duplicates

Sampling Program	Original Result				Field Duplicate Result				Poisson Rate Comparison (90% CI)
	Index ID	Number LA Structures	Sensitivity ($1/cm^2$)	Total LA Conc (s/cm^2)	Index ID	Number LA Structures	Sensitivity ($1/cm^2$)	Total LA Conc (s/cm^2)	
OU4 Indoor Activity-Based Sampling	IN-00589	0	1.7E+01	0.0E+00	IN-00591	0	1.7E+01	0.0E+00	Both counts are 0; the rates are not different
	IN-00608	0	1.7E+01	0.0E+00	IN-00609	0	1.7E+01	0.0E+00	Both counts are 0; the rates are not different
	IN-00860	0	1.7E+01	0.0E+00	IN-00852	0	1.7E+01	0.0E+00	Both counts are 0; the rates are not different
	IN-00893	0	1.7E+01	0.0E+00	IN-00895	0	1.7E+01	0.0E+00	Both counts are 0; the rates are not different
	IN-01345	0	1.7E+01	0.0E+00	IN-01343	0	1.7E+01	0.0E+00	Both counts are 0; the rates are not different
	IN-01364	0	1.7E+01	0.0E+00	IN-01365	0	1.7E+01	0.0E+00	Both counts are 0; the rates are not different
	IN-01582	0	2.0E+01	0.0E+00	IN-01583	0	2.0E+01	0.0E+00	Both counts are 0; the rates are not different
	IN-01588	0	1.9E+01	0.0E+00	IN-01589	0	1.9E+01	0.0E+00	Both counts are 0; the rates are not different
	IN-01683	0	1.9E+01	0.0E+00	IN-01684	0	1.9E+01	0.0E+00	Both counts are 0; the rates are not different
	IN-01944	0	1.8E+01	0.0E+00	IN-01945	0	1.8E+01	0.0E+00	Both counts are 0; the rates are not different
	IN-01977	0	1.4E+01	0.0E+00	IN-01978	0	1.8E+01	0.0E+00	Both counts are 0; the rates are not different
	IN-02342	0	2.0E+01	0.0E+00	IN-02343	0	1.5E+01	0.0E+00	Both counts are 0; the rates are not different
	IN-02388	0	2.0E+01	0.0E+00	IN-02389	0	2.0E+01	0.0E+00	Both counts are 0; the rates are not different
	IN-02617	0	1.8E+01	0.0E+00	IN-02618	0	1.8E+01	0.0E+00	Both counts are 0; the rates are not different
	IN-02655	0	1.4E+01	0.0E+00	IN-02657	0	1.8E+01	0.0E+00	Both counts are 0; the rates are not different
	IN-02837	0	2.0E+01	0.0E+00	IN-02838	0	1.7E+01	0.0E+00	Both counts are 0; the rates are not different
	IN-02938	0	1.7E+01	0.0E+00	IN-02941	0	1.7E+01	0.0E+00	Both counts are 0; the rates are not different
Stimson Lumber	SL-70497	0	1.3E+01	0.0E+00	SL-70498	1	6.3E+00	6.3E+00	[0-38] The rates are not different
	SL-70653	0	4.6E+01	0.0E+00	SL-70655	0	4.6E+01	0.0E+00	Both counts are 0; the rates are not different
Phase 2	2-00473	0	5.9E+02	0.0E+00	2-00474	0	5.7E+02	0.0E+00	Both counts are 0; the rates are not different
	2-00627	1	5.9E+02	5.9E+02	2-00628	0	5.7E+02	0.0E+00	[0-18.35] The rates are not different
	2-00678	0	5.9E+02	0.0E+00	2-00679	0	5.7E+02	0.0E+00	Both counts are 0; the rates are not different

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cc = cubic centimeter
CI = confidence interval
Conc = concentration
LA = Libby amphibole
s/cc = structues per cubic centimeter
SQAPP = supplemental quality assurance project plan
TEM = transmission electron microscopy

TABLE 6-6. PCM FIELD DUPLICATE SUMMARY

Original Results								Duplicate Results					Poisson Ratio Comparison (90% CI)
Sampling Program	Index ID	Sample Date	Air Volume (L)	Prep	Number of Structures Observed	LOD (s/cc)	PCM Air Conc (s/cc)	Index ID	Prep	Number of Structures Observed	LOD (s/cc)	PCM Air Conc (s/cc)	
Phase 2	2-00157	3/24/01	4829	direct	56	1.1E-04	0.0060	2-00158	direct	56	1.1E-04	0.0060	[0.72-1.39] The rates are not different
	2-00249	3/29/01	4942	direct	53	1.1E-04	0.0050	2-00250	direct	56	8.9E-05	0.0060	[0.86-1.67] The rates are not different
	2-00466	5/14/01	1267	indirect	35	1.0E-02	0.3640	2-00467	indirect	4	9.1E-02	<0.057	[0.4-3.07] The rates are not different
	2-00478	5/14/01	424	direct	6	2.0E-03	0.0070	2-00479	direct	10	7.0E-04	0.0120	[0.62-4.45] The rates are not different
	2-00619	5/5/01	1472	direct	3	3.3E-04	<0.0018	2-00622	direct	2	3.3E-04	<0.0018	[0.23-12.08] The rates are not different
	2-00633	5/5/01	401	direct	15	1.4E-03	0.0180	2-00636	direct	17	1.1E-03	0.0210	[0.61-2.22] The rates are not different
	2-00659	5/7/01	1206	direct	1	4.0E-04	<0.0022	2-00662	direct	3	4.0E-04	<0.0022	[0.01-3.02] The rates are not different
	2-00669	5/7/01	1760	indirect	0	7.5E-03	<0.041	2-00671	indirect	0	7.5E-03	<0.041	Both counts are 0; the rates are not different
	2-00683	**5/7/01**	**468**	**direct**	**13**	**1.1E-03**	**0.0140**	**2-00685**	**direct**	**27**	**1.0E-03**	**0.0280**	**[0.27-0.91] Rate 1 is less than Rate 2**
	2-00809	5/16/01	1203	direct	5	4.0E-04	<0.0022	2-00810	direct	2	4.0E-04	<0.0022	[0.52-17.74] The rates are not different
Stimson Lumber	SL-00023	9/11/02	4790	direct	0.5	1.8E-04	<0.001	SL-00024	direct	1.5	1.8E-04	<0.001	[0-3.47] The rates are not different
	SL-00213	9/17/02	2180	direct	2	1.8E-04	<0.001	SL-00214	direct	0	1.8E-04	<0.001	[0-3.47] The rates are not different
	SL-00222	9/17/02	2942	direct	6	1.7E-04	0.0010	SL-00223	direct	6.5	1.5E-04	0.0010	[0.35-3.33] The rates are not different

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CI = confidence interval
L = liter
LOD = limit of detection
PCM = phase contrast microscopy
s/cc = structures per cubic centimeter

TABLE 6-7. SOIL FIELD SPLIT COLLECTION FREQUENCY

Year	Number of Soil Samples		Field Split Collection Frequency
	Field Splits	Field Samples	
1999	42	410	10%
2000	66	914	7%
2001	123	2,149	6%
2002	417	9,793	4%
1999-2002	648	13,266	5%

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TABLE 6-8. COMPARISON OF SOIL FIELD SPLITS

Panel A: PLM-NIOSH 9002

		Field Split Results		
		ND	<1%	≥1%
Original Sample Results	ND	84	8	0
	<1%	10	20	1
	≥1%	1	1	2

Total Pairs	127
Concordant	106 (83.5%)
Weakly Discordant	20 (15.7%)
Strongly Discordant	1 (0.8%)

Panel B: PLM-VE

		Field Split Results			
		Bin A (ND)	Bin B1 (Tr)	Bin B2 (<1%)	Bin C (≥1%)
Original Sample Results	Bin A (ND)	266	16	1	0
	Bin B1 (Tr)	11	15	0	0
	Bin B2 (<1%)	0	3	1	0
	Bin C (≥1%)	0	0	0	0

Total Pairs	313
Concordant	282 (90.1%)
Weakly Discordant	30 (9.6%)
Strongly Discordant	1 (0.3%)

Panel C: Across PLM Methods

		Results by PLM-VE		
		Bin A (ND)	Bin B1 (Tr) or Bin B2 (<1%)	Bin C (≥1%)
Results by NIOSH (9002)	ND	141	16	0
	<1%	20	24	4
	≥1%	0	0	3

Total Pairs	208
Concordant	168 (80.8%)
Weakly Discordant	40 (19.2%)
Strongly Discordant	0 (0%)

OVERALL CONCORDANCE	
Total Pairs	**648**
N Concordant	**556 (85.8%)**
N Weakly Discordant	**90 (13.9%)**
N Strongly Discordant	**2 (0.3%)**

Concordant pairs are shaded in gray.

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PLM = polarized light microscopy
ND = non-detect
NIOSH = National Institute for Occupational Safety and Health
Tr = trace
VE = visual area estimation
<= less than
≥ = greater than or equal to

TABLE 6-9. SOIL FIELD DUPLICATE COLLECTION FREQUENCY

Year	Number of Soil Samples		Field Duplicate Collection Frequency
	Field Duplicate	Field Samples	
1999	3	410	0.7%
2000	21	914	2.3%
2001	148	2,149	6.9%
2002	201	9,793	2.1%
2003	131	3,343	3.9%
2004	35	1,642	2.1%
2005	34	2,141	1.6%
2006	73	3,093	2.4%
2007	103	4,285	2.4%
2008	56	3,233	1.7%
2009	14	1,605	0.9%
1999-2009	819	32,608	2.5%

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TABLE 6-10. COMPARISON OF FIELD DUPLICATES

Panel A: PLM-NIOSH 9002

		Field Duplicate Results		
		ND	<1%	≥1%
Original Sample Results	ND	110	9	1
	<1%	16	34	4
	≥1%	0	0	14

Total Pairs	188
Concordant	158 (84%)
Weakly Discordant	29 (15.4%)
Strongly Discordant	1 (0.5%)

Panel B: PLM-VE

		Field Duplicate Results			
		Bin A (ND)	Bin B1 (Tr)	Bin B2 (<1%)	Bin C (≥1%)
Original Sample Results	Bin A (ND)	503	31	2	0
	Bin B1 (Tr)	28	37	6	1
	Bin B2 (<1%)	1	2	4	0
	Bin C (≥1%)	1	1	0	0

Total Pairs	617
Concordant	544 (88.2%)
Weakly Discordant	67 (10.9%)
Strongly Discordant	6 (1%)

Panel C: Across PLM Methods

		Sample Result by PLM-VE		
		Bin A (ND)	Bin B1 (Tr) or Bin B2 (<1%)	Bin C (≥1%)
Sample Result by NIOSH	ND	4	0	0
	<1%	7	3	0
	≥1%	0	0	0

Total Pairs	14
Concordant	7 (50%)
Weakly Discordant	7 (50%)
Strongly Discordant	0 (0%)

OVERALL CONCORDANCE	
Total Pairs	**819**
N Concordant	**709 (86.6%)**
N Weakly Discordant	**103 (12.6%)**
N Strongly Discordant	**7 (0.9%)**

Concordant pairs are shaded in gray.

Libby 2DB Download: 12/8/09

PLM = polarized light microscopy
ND = non-detect
NIOSH = National Institute for Occupational Safety and Health
Tr = trace
VE = visual area estimation
<= less than
≥ = greater than or equal to

TABLE 6-11. RINSATE BLANK SUMMARY

Index ID	Sample Date	Number of Structures Observed*		
		LA	OA	C
CS-00218	6/18/02	0	0	0
CS-00515	6/17/02	0	0	0
CS-00661	6/19/02	0	0	0
CS-00785	6/20/02	1	0	0
CS-00899	6/21/02	0	0	0
CS-00944	6/22/02	0	0	0
CS-03656	8/5/02	0	0	0
CS-03777	8/6/02	0	0	0
CS-03891	8/7/02	0	0	0
CS-03920	8/8/02	0	0	0
CS-03953	8/9/02	0	0	0
CS-04126	8/10/02	0	0	0
CS-10051	10/24/02	0	0	0
CS-10135	10/23/02	0	0	0
CS-10190	10/25/02	1	0	0
CS-10336	10/28/02	0	0	0
CS-10340	10/26/02	0	0	0
CS-10395	10/31/02	0	0	0
LB-00038	6/10/08	0	0	0
LB-00077	6/11/08	0	0	0

*Samples were analyzed using TEM - EPA 100.2.

Libby2DB Download: 12/8/09

C = chrysotile
LA = Libby amphibole
OA = other amphibole
TEM = transmission electron microscopy

TABLE 7-1. PREPARATION BLANKS ANALYZED BY PLM-VE

Preparation Blank Type	Number of Samples Analyzed	Results
Drying Blank	959	958 non-detect (Bin A) 1 trace (Bin B1)
Grinding Blank	1,245	1,241 non-detect (Bin A) 4 trace (Bin B1)

Libby2DB Download: 12/8/09

PLM-VE = polarized light microscopy visual area estimation

TABLE 7-2. COMPARISON OF PREPARATION DUPLICATES ANALYZED BY PLM-VE

		Preparation Duplicate Results			
		Bin A (ND)	Bin B1 (Tr)	Bin B2 (<1%)	Bin C (≥1%)
Original Sample Results	Bin A (ND)	1208	44	3	1
	Bin B1 (Tr)	57	88	5	0
	Bin B2 (<1%)	1	0	8	1
	Bin C (≥1%)	0	0	1	3

Total Pairs	1420
Concordant	1307 (92%)
Weakly Discordant	108 (7.6%)
Strongly Discordant	5 (0.4%)

Concordant pairs are shaded in gray.
Libby 2DB Download: 12/8/09

ND = non-detect
PLM-VE = polarized light microscopy visual area estimation
Tr = trace

TABLE 8-1. TEM LABORATORY BLANK SUMMARY

Panel A: TEM Laboratory Blank Frequency by Laboratory and Year

Year	Batta		Hygeia		MAS		RESI		Mobile Lab		EMSL (all labs)		Total (All Labs)	
	N Blanks/ N Samples	Frequency	N Blanks/ N Samples	Frequency	N Blanks/ N Samples	Frequency	N Blanks/ N Samples	Frequency	N Blanks/ N Samples	Frequency	N Blanks/ N Samples	Frequency	N Blanks/ N Samples	Frequency
1999	--	--	--	--	--	--	0/1	0%	--	--	--	--	0/1	0%
2000	--	--	--	--	--	--	6/556	1.1%	0/1756	0%	1/1478	0.1%	7/3790	0.2%
2001	--	--	--	--	--	--	2/1130	0.2%	172/5225	3.3%	104/2644	3.9%	278/8999	3.1%
2002	17/320	5.3%	11/380	2.9%	--	--	39/1154	3.4%	191/3797	5%	48/894	5.4%	306/6545	4.7%
2003	3/108	2.8%	2/63	3.2%	2/45	4.4%	6/154	3.9%	241/5938	4.1%	9/111	8.1%	263/6419	4.1%
2004	0/29	0%	3/63	4.8%	4/28	14.3%	12/257	4.7%	141/3635	3.9%	7/88	8%	167/4100	4.1%
2005	0/164	0%	7/191	3.7%	15/195	7.7%	17/411	4.1%	165/4274	3.9%	29/264	11%	233/5499	4.2%
2006	0/51	0%	4/107	3.7%	3/51	5.9%	15/277	5.4%	174/4147	4.2%	28/189	14.8%	224/4822	4.6%
2007	0/80	0%	11/254	4.3%	84/576	14.6%	42/596	7%	97/2952	3.3%	44/284	15.5%	278/4742	5.9%
2008	0/14	0%	15/337	4.5%	27/161	16.8%	24/354	6.8%	109/2851	3.8%	7/128	5.5%	182/3845	4.7%
2009	--	--	1/2	50%	2/0*	--	6/70	8.6%	76/1840	4.1%	--	--	85/1912	4.4%
Total	20/766	2.6%	54/1397	3.9%	137/1056	13%	169/4960	3.4%	1366/36415	3.8%	277/6080	4.6%	2023/50674	4%

* = a small number of laboratory blanks were analyzed because other lab quality control samples were also analyzed.

Panel B: TEM Laboratory Blank Results

Preparation Method	Number of Analyses	Asbestos Detection Frequency	Total Area Examined (mm^2)	Total Asbestos Structures Observed		
				LA	OA	C
Direct	1,452	1 (0.07%)	191	0	0	1
Indirect	523	2 (0.4%)	57	0	0	8
Indirect-Ashed	48	1 (2.1%)	7.2	0	0	52
All	2,023	4 (0.2%)	255	0	0	61

Libby2DB Download: 12/8/09

Batta = Batta Environmental Associates, Inc.
C = chrysotile
Hygeia = Hygeia Laboratories, Inc.
LA = Libby amphibole
MAS = Material Analytical Services, LLC
mm^2 = square millimeters
N = number
OA = other amphibole
RESI = Reservoir Environmental Services, Inc.
TEM = transmission electron microscopy

TABLE 8-2. TEM RECOUNT CONCORDANCE RESULTS BASED ON TOTAL LA COUNTS

Panel A: Recount Same Analysis Results[a]

		Recount Same Count							
		0	1	2	3	4	5	6	7
Original Count	0	**8188**	11						
	1	8	243	4					
	2	1	6	53	1				
	3				11				
	4				2	7			
	5						2		
	6								
	7								1

Panel B: Recount Different and Verified Analysis Results

		Recount Different/Verified Analysis Count										
		0	1	2	3	4	5	6	7	8	9	10
Original Count	0	**14041**	38	1	2							
	1	32	447	11	3	2						
	2		12	82	7		1					
	3				26	2						
	4				2	17	2	1				
	5						4	2				
	6		1					4				
	7								3	1		
	8							1		1		
	9										2	
	10											2

Recount Same Concordance

Total Pairs **8,540**

C1-C2	N	%
0	8,505	99.6%
1	33	0.4%
2	1	0.01%
3	0	0.0%
4	1	0.01%
5	0	0.0%

Recount Different/Verified AnalysisConcordance

Total Pairs **14,750**

C1-C2	N	%
0	14,629	99.2%
1	109	0.7%
2	6	0.04%
3	5	0.03%
4	0	0.0%
5	1	0.01%

[a] Not all grid opening pairs are displayed in the table above. Grid opening pairs not shown include:
Original GO Count = 14, Lab QC GO Count = 13 (ranked as concordant)
Original GO Count = 13, Lab QC GO Count = 9 (ranked as discordant)

Libby 2DB Download: 12/8/09
See Appendix C for detailed results.

C1 = original analysis structure count
C2 = recount analysis structure count
GO = grid opening
LA = Libby amphibole
TEM = transmission electron microscopy

TABLE 8-3. RECOUNT SAME, RECOUNT DIFFERENT, AND VERIFIED ANALYSIS CONCORDANCE OF LA STRUCTURES

Panel A: Results for Matched Structures

Attribute	Number Concordant	
Mineral Class	1,405/1,415	99%
Structure Length	1,182/1,415	84%
Structure Width	1,244/1,415	88%

Panel B: Attributes of Mis-Matched LA Structures

Structure Type	N	Percentage of Total	Length		Width		Aspect Ratio	
			Mean	Range	Mean	Range	Mean	Range
Bundle	9	6%	6.3	3.0 - 15	0.9	0.1 - 4.0	16	3.6 - 65
Cluster	4	3%	2.6	0.8 - 6.0	0.2	0.1 - 0.3	11	5.0 - 20
Fiber	117	79%	5.1	0.4 - 53	0.5	0.1 - 4.0	13	1.3 - 51
Matrix	19	13%	3.2	0.8 - 8.4	0.3	0.1 - 1.2	13	5.0 - 38

Panel C: Attributes of Matched LA Structures

Structure Type	N	Percentage of Total	Length		Width		Aspect Ratio	
			Mean	Range	Mean	Range	Mean	Range
Bundle	287	10%	10	1.0 - 152	0.9	0.2 - 16	12	1.5 - 101
Cluster	3	0.1%	12	10.0 - 16	2.3	1.0 - 3.0	7.6	3.3 - 16
Fiber	2,142	76%	6.9	0.7 - 89	0.5	0.1 - 3.9	16	1.3 - 194
Matrix	386	14%	6.3	0.6 - 56	0.8	0.1 - 13	14	1.0 - 92

Libby 2DB Download: 12/8/09.

See Appendix C for detailed results.

LA = Libby amphibole

TABLE 8-4. TEM INTERLAB CONCORDANCE RESULTS BASED ON TOTAL LA COUNTS

Original Analysis Grid Opening Count	Interlab Analysis Grid Opening Count [a]															
	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
0	228	13	4		1											
1	8	31	2	2							1					
2	1	4	12	3	2		1									
3		5	1	5	1	5	3									
4	1		1	3	4	1	1									
5				1		1	1	4								
6				2		1	5	2		1	1					
7						2	1	1	2	1						
8				1			1	1	2	2	2					
9									1		1					
10						1		1		1	1					
11													1			
12															1	
13												1				
14																1
15											1					

Total GO Pairs 395

C1-C2	N	%
0	291	74%
1	52	13%
2	34	9%
3	9	2%
4	4	1%
5	3	1%

[a] Not all grid opening pairs are displayed. Grid opening pairs not shown include:
Original GO Count = 16, Interlab GO Count = 16 (ranked as concordant)
Original GO Count = 12, Interlab GO Count = 18 (ranked as disconcordant)
Original GO Count = 22, Interlab GO Count = 21 (ranked as concordant)
Original GO Count = 22, Interlab GO Count = 25 (ranked as disconcordant)
Original GO Count = 16, Interlab GO Count = 13 (ranked as disconcordant)

Concordant pairs are shaded in gray.

Libby 2DB Download: 12/8/09.
See Appendix D for detailed results.

C1 = original analysis structure count
C2 =interlab analysis structure count
GO = grid opening
LA = Libby amphibole
TEM = transmission electron microscopy

TABLE 8-5. INTERLAB CONCORDANCE OF LA STRUCTURES

Panel A: Results for 546 Matched Structures

Attribute	Number Concordant	
Mineral Class	534/546	98%
Structure Length	460/546	84%
Structure Width	534/546	98%

Panel B: Attributes of Mis-Matched LA Structures

Structure Type	N	Percentage of Total	Length		Width		Aspect Ratio	
			Mean	Range	Mean	Range	Mean	Range
Bundle	13	5%	8.9	1.6 - 51	0.8	0.1 - 1.9	12	2.7 - 30
Cluster	1	0%	1.8	1.8 - 1.8	1.5	1.5 - 1.5	1.2	1.2 - 1.2
Fiber	149	63%	3.3	0.7 - 22	0.3	0.02 - 1.6	13	3.0 - 58
Matrix	74	31%	6.0	0.5 - 38	0.7	0.1 - 12	14	1.1 - 76

Panel C: Attributes of Matched LA Structures

Structure Type	N	Percentage of Total	Length		Width		Aspect Ratio	
			Mean	Range	Mean	Range	Mean	Range
Bundle	55	5%	10.7	0.8 - 55	0.6	0.2 - 2.2	16.5	1.3 - 92
Cluster	6	1%	45.4	13 - 110	6.6	0.6 - 15	10.1	3.5 - 25
Fiber	819	76%	6.1	0.6 - 45	0.5	0.05 - 3.0	15.3	2.5 - 79
Matrix	198	18%	6.8	0.8 - 52	0.5	0.1 - 3.0	17.1	1.1 - 187

Libby 2DB Download: 12/8/09
See Appendix D for detailed results.

LA = Libby amphibole
N = number

TABLE 8-6. TEM REPREPARATION SUMMARY

Panel A: Repreparation Frequency by Year

Year	Batta		Hygeia		MAS		RESI		Mobile Lab		EMSL (all labs)		Total (All Labs)	
	NRepreps/ N Samples	Frequency	NRepreps/ N Samples	Frequency	NRepreps/ N Samples	Frequency	NRepreps/ N Samples	Frequency	NRepreps/ N Samples	Frequency	NRepreps/ N Samples	Frequency	NRepreps/ N Samples	Frequency
1999	--	--	--	--	--	--	0/1	0%	--	--	--	--	0/1	0%
2000	--	--	--	--	--	--	8/556	1.4%	0/1756	0%	0/1478	0%	8/3790	0.2%
2001	--	--	--	--	--	--	20/1130	1.8%	199/5225	3.8%	22/2644	0.8%	241/8999	2.7%
2002	18/320	5.6%	5/380	1.3%	--	--	45/1154	3.9%	54/3797	1.4%	32/894	3.6%	154/6545	2.4%
2003	1/108	0.9%	1/63	1.6%	3/45	6.7%	2/154	1.3%	59/5938	1%	45/111	40.5%	111/6419	1.7%
2004	0/29	0%	0/63	0%	1/28	3.6%	2/257	0.8%	36/3635	1%	27/88	30.7%	66/4100	1.6%
2005	0/164	0%	1/191	0.5%	1/195	0.5%	4/411	1%	43/4274	1%	41/264	15.5%	90/5499	1.6%
2006	1/51	2%	3/107	2.8%	3/51	5.9%	2/277	0.7%	52/4147	1.3%	44/189	23.3%	105/4822	2.2%
2007	0/80	0%	1/254	0.4%	4/576	0.7%	6/596	1%	39/2952	1.3%	14/284	4.9%	64/4742	1.3%
2008	1/14	7.1%	4/337	1.2%	4/161	2.5%	3/354	0.8%	31/2851	1.1%	7/128	5.5%	50/3845	1.3%
2009	--	--	0/2	0%	3/0 *	--	0/70	0%	23/1840	1.3%	1/0	--	27/1912	1.4%
Total	21/766	2.7%	15/1397	1.1%	19/1056	1.8%	92/4960	1.9%	536/36415	1.5%	233/6080	3.8%	916/50674	1.8%

* = a small number of laboratory blanks were analyzed because other laboratory quality control samples were also analyzed.

Panel B: Repreparation Results Summary

Medium	N Paired Analyses	N Analyses w/LA Structures Observed	Concordant Pairs	Discordant Pairs	Concordance Rate
Air	742	184	713	29	713/742 (96%)
Dust	174	39	171	3	171/174 (98%)
Total	916	223	884	32	884/916 (97%)

Libby2DB Download: 12/8/09

Batta = Batta Environmental Associates, Inc.
Hygeia = Hygeia Laboratories, Inc.
LA = Libby amphibole
MAS = Material Analytical Services, LLC
N = number
Reprep = repreparation
RESI = Reservoir Environmental Services, Inc.
TEM = transmission electron microscopy

TABLE 10-1. PLM-VE LAB DUPLICATE COLLECTION FREQUENCY

Year	Batta		Hygeia		MAS		RESI		Mobile Lab		EMSL (Westmont Only)		ESAT		Total (All Labs)	
	N Dups/ N Samples	Frequency	N Dups/ N Samples	Frequency	N Dups/ N Samples	Frequency	N Dups/ N Samples	Frequency	N Dups/ N Samples	Frequency	N Dups/ N Samples	Frequency	N Blanks/ N Samples	Frequency	N Dups/ N Samples	Frequency
2002	1/10	10%	--	--	--	--	5/36	13.9%	--	--	--	--	--	--	6/46	13%
2003	106/956	11.1%	136/1356	10%	120/1144	10.5%	233/2105	11.1%	15/115	13%	172/1502	11.5%	--	--	782/7178	10.9%
2004	196/1776	11%	187/1870	10%	148/1460	10.1%	261/2251	11.6%	--	--	233/1999	11.7%	--	--	1025/9356	11%
2005	--	--	0/1	0%	--	--	182/1495	12.2%	--	--	--	--	--	--	182/1496	12.2%
2006	--	--	--	--	--	--	319/2638	12.1%	--	--	--	--	--	--	319/2638	12.1%
2007	--	--	--	--	--	--	389/3536	11%	0/1	0%	--	--	--	--	389/3537	11%
2008	20/161	12.4%	24/195	12.3%	25/210	11.9%	156/1432	10.9%	0/8	0%	1/9	11.1%	14/136	10.3%	240/2151	11.2%
2009	15/104	14.4%	19/148	12.8%	14/113	12.4%	79/581	13.6%	0/79	0%	--	--	22/239	9.2%	149/1264	11.8%
Total	338/3007	11.2%	366/3570	10.3%	307/2927	10.5%	1624/14074	11.5%	15/203	7.4%	406/3510	11.6%	36/375	9.6%	3092/27666	11.2%

-- = lab did not perform analyses during this year
Libby 2DB Download: 12/8/09.

Batta = Batta Environmental Associates, Inc.
Dups = duplicates
ESAT = Environmental Services Assistance Team
Hygeia = Hygeia Laboratories, Inc.
MAS = Material Analytical Services, LLC
N = number
PLM-VE = polarized light microscopy visual estimation
RESI = Reservoir Environmental Services, Inc.

TABLE 10-2. COMPARISON OF LABORATORY DUPLICATES ANALYZED BY PLM-VE

Panel A: Laboratory Duplicates/Cross-Checks

		Laboratory Duplicate Results			
		Bin A (ND)	Bin B1 (Tr)	Bin B2 (<1%)	Bin C (≥1%)
Original Analysis Results	Bin A (ND)	2,424	10	0	0
	Bin B1 (Tr)	19	445	2	0
	Bin B2 (<1%)	2	5	34	0
	Bin C (≥1%)	1	0	0	22

Total Pairs	2,964
Concordant	2925 (98.7%)
Weakly Discordant	36 (1.2%)
Strongly Discordant	3 (0.1%)

Panel B: Laboratory Self-Checks

		Laboratory Duplicate Results			
		Bin A (ND)	Bin B1 (Tr)	Bin B2 (<1%)	Bin C (≥1%)
Original Analysis Results	Bin A (ND)	118	1	0	0
	Bin B1 (Tr)	3	4	0	0
	Bin B2 (<1%)	1	0	0	0
	Bin C (≥1%)	0	0	0	1

Total Pairs	128
Concordant	123 (96.1%)
Weakly Discordant	4 (3.1%)
Strongly Discordant	1 (0%)

Concordant pairs are shaded in gray.
Libby 2DB Download: 12/8/09.

ND = non-detect
PLM-VE = polarized light microscopy visual area estimation
Tr = trace

TABLE 10-3. COMPARISON OF PLM-VE INTERLAB ANALYSIS RESULTS FOR 2001-2004

		Interlab Analysis Results			
		Bin A (ND)	Bin B1 (Tr)	Bin B2 (<1%)	Bin C (≥1%)
Original Analysis Results	Bin A (ND)	30	1	0	0
	Bin B1 (Tr)	1	0	0	0
	Bin B2 (<1%)	0	0	0	0
	Bin C (≥1%)	0	0	0	0

Total Pairs	32
Concordant	30 (93.8%)
Weakly Discordant	2 (6.3%)
Strongly Discordant	0 (0%)

N Original > Interlab	N Interlab > Original
1/2 (50%)	1/2 (50%)

Concordant pairs are shaded in gray.

Libby 2DB Download: 12/8/09.

N = number

ND = non-detect

PLM-VE = polarized light microscopy visual area estimation

Tr = trace

TABLE 10-4. COMPARISON OF PLM-VE INTERLAB ANALYSIS RESULTS FOR THE 2004 CSS PILOT STUDY

		Interlab Analysis Results			
		Bin A (ND)	Bin B1 (Tr)	Bin B2 (<1%)	Bin C (≥1%)
Original Analysis Results	Bin A (ND)	14	3	0	0
	Bin B1 (Tr)	10	7	2	0
	Bin B2 (<1%)	3	9	3	4
	Bin C (≥1%)	0	2	1	2

Total Pairs	60
Concordant	26 (43.3%)
Weakly Discordant	29 (48.3%)
Strongly Discordant	5 (8.3%)

N Original > Interlab	N Interlab > Original
25/34 (74%)	9/34 (26%)

Concordant pairs are shaded in gray.
Libby 2DB Download: 12/8/09.

CSS = Contaminant Screening Study
N = number
ND = non-detect
PLM-VE = polarized light microscopy visual area estimation
Tr = trace

TABLE 10-5. COMPARISON OF PLM-VE INTERLAB ANALYSIS RESULTS FOR THE POST HOC SELECTION

		Interlab Analysis Results			
		Bin A (ND)	Bin B1 (Tr)	Bin B2 (<1%)	Bin C (≥1%)
Original Analysis Results	Bin A (ND)	18	0	0	0
	Bin B1 (Tr)	11	3	0	0
	Bin B2 (<1%)	0	4	0	1
	Bin C (≥1%)	1	0	1	0

Total Pairs	39
Concordant	21 (53.8%)
Weakly Discordant	17 (43.6%)
Strongly Discordant	1 (2.6%)

N Original > Interlab	N Interlab > Original
17/18 (94%)	1/18 (6%)

Concordant pairs are shaded in gray.
Libby 2DB Download: 12/8/09.

N = number
ND = non-detect
PLM-VE = polarized light microscopy visual area estimation
Tr = trace

TABLE 10-6. COMPARISON OF PLM-VE INTERLAB ANALYSIS RESULTS FOR 2008 ESAT/RESI INTERLAB STUDY, ROUND 1

		Interlab Analysis Results (ESAT)			
		Bin A (ND)	Bin B1 (Tr)	Bin B2 (<1%)	Bin C (≥1%)
Original Analysis Results (RESI)	Bin A (ND)	11	14	0	0
	Bin B1 (Tr)	0	3	1	0
	Bin B2 (<1%)	0	1	4	1
	Bin C (≥1%)	0	0	0	0

Total Pairs	35
Concordant	18 (51.4%)
Weakly Discordant	17 (48.6%)
Strongly Discordant	0 (0%)

N Original > Interlab	N Interlab > Original
1/17 (6%)	16/17 (94%)

Concordant pairs are shaded in gray.
Libby 2DB Download: 12/8/09.

ESAT = Environmental Services Assistance Team
N = number
ND = non-detect
PLM-VE = polarized light microscopy visual area estimation
RESI = Reservoir Environmental Services, Inc.
Tr = trace

TABLE 10-7. DECEMBER 2008 PLM-VE INTERLAB ROUND ROBIN STUDY

Index ID	Original	Interlab		
	RESI	Hygeia	Mobile Lab	MAS
SL-00621	ND	ND	ND	ND
SL-00637	Tr	ND	Tr	ND
SL-00686	ND	ND	ND	ND
SL-00750	ND	ND	ND	ND
SL-00756	ND	ND	ND	ND
SL-00789	ND	ND	ND	ND
SL-00838	ND	ND	Tr	ND
SL-01000	ND	ND	ND	ND

Libby 2DB Download: 12/8/09

Hygeia = Hygeia Laboratories, Inc.
MAS = Material Analytical Services, LLC
ND = non-detect
PLM-VE = polarized light microscopy visual area estimation
RESI = Reservoir Environmental Services, Inc.
Tr = trace

TABLE 10-8. COMPARISON OF PLM-VE INTERLAB ANALYSIS RESULTS FOR 2008 ESAT/RESI INTERLAB STUDY, ROUND 2

		Interlab Analysis Results (RESI)			
		Bin A (ND)	Bin B1 (Tr)	Bin B2 (<1%)	Bin C (≥1%)
Original Analysis Results (ESAT)	Bin A (ND)	12	2	0	0
	Bin B1 (Tr)	9	1	0	0
	Bin B2 (<1%)	0	0	0	0
	Bin C (≥1%)	0	0	0	0

Total Pairs	24
Concordant	13 (54.2%)
Weakly Discordant	11 (45.8%)
Strongly Discordant	0 (0%)

N Original > Interlab	N Interlab > Original
9/11 (82%)	2/11 (18%)

Concordant pairs are shaded in gray.
Libby 2DB Download: 12/8/09.

ESAT = Environmental Services Assistance Team
N = number
ND = non-detect
PLM-VE = polarized light microscopy visual area estimation
RESI = Reservoir Environmental Services, Inc.
Tr = trace